PROCEEDINGS

Thirtieth Annual Western Forest Insect Work Conference

BOISE, IDAHO

MARCH 6-8, 1979

Not for Publication

(For Information of Conference Members Only)

Prepared at

Pacific Forest Research Centre

Victoria, British Columbia

PROCEEDINGS

THIRTIETH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

Boise, Idaho

March 6-8, 1979

Executive Committee (Thirtieth WFIWC)

W. Ives, Edmonton	Chairman
R. L. Johnsey, Olympia	Immediate Past Chairman
L. Safranyik, Victoria	Secretary-Treasurer
S. Cade, Hot Springs	Councilor (1976)
J. McLean, Vancouver	Councilor (1977)
W. M. Ciesla, Davis	Councilor (1978)
M. M. Ollieu	Program Chairman
J. A. E. Knopf	Local Arrangement Chairman

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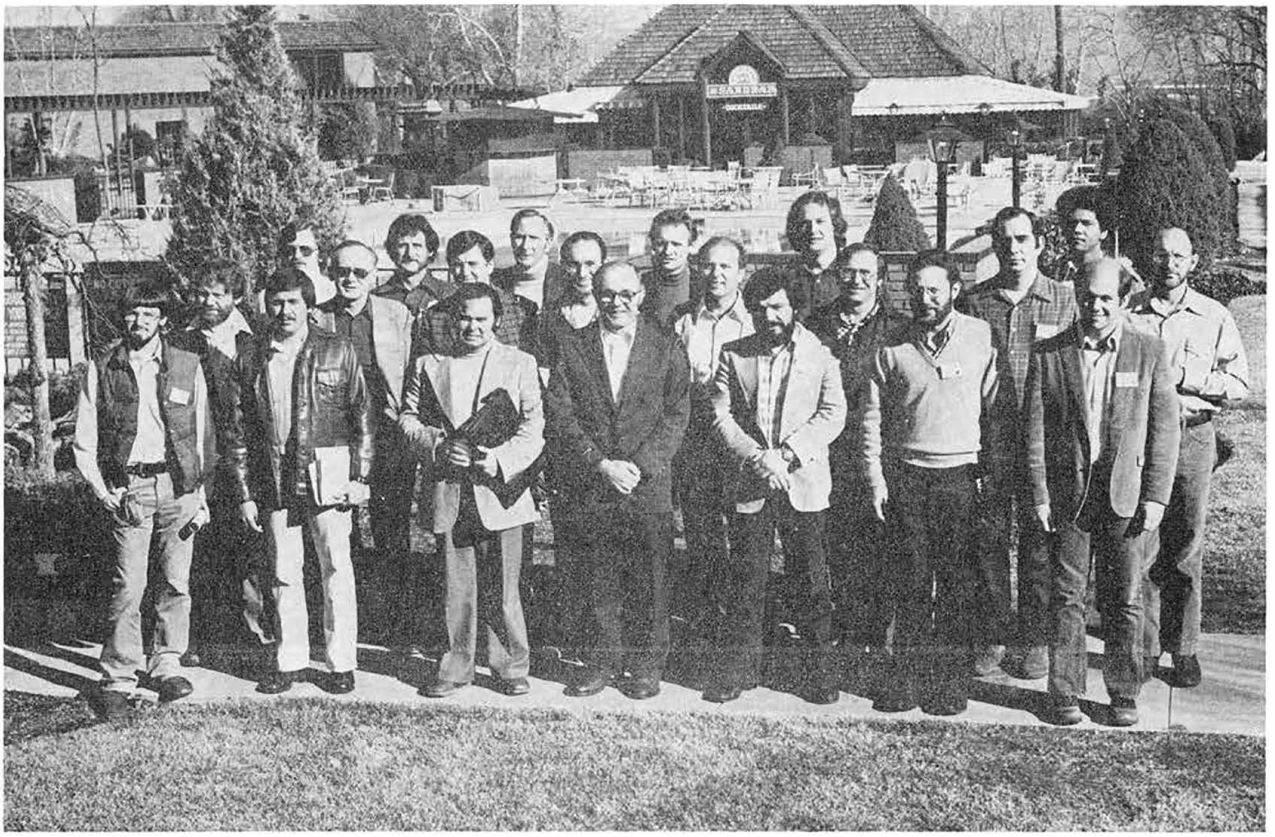
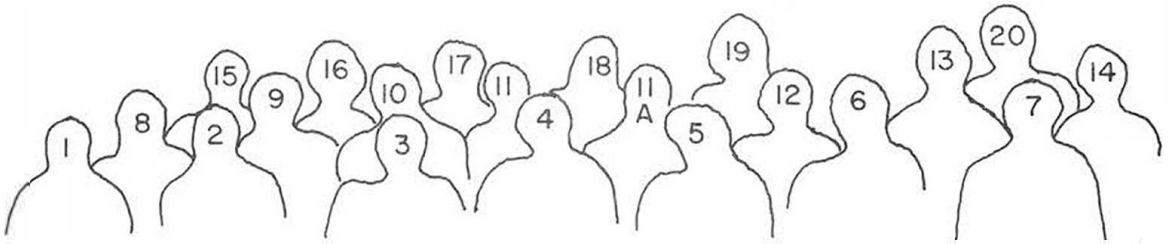
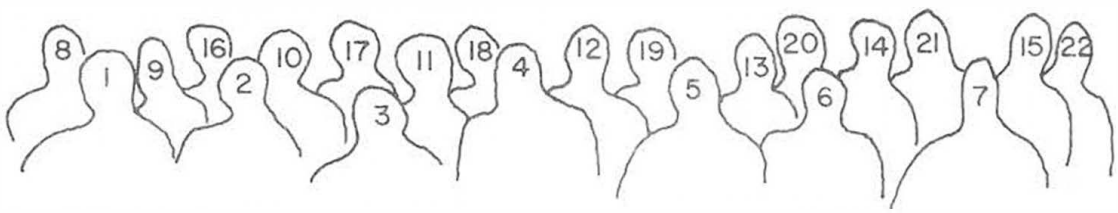
*Summary not submitted.

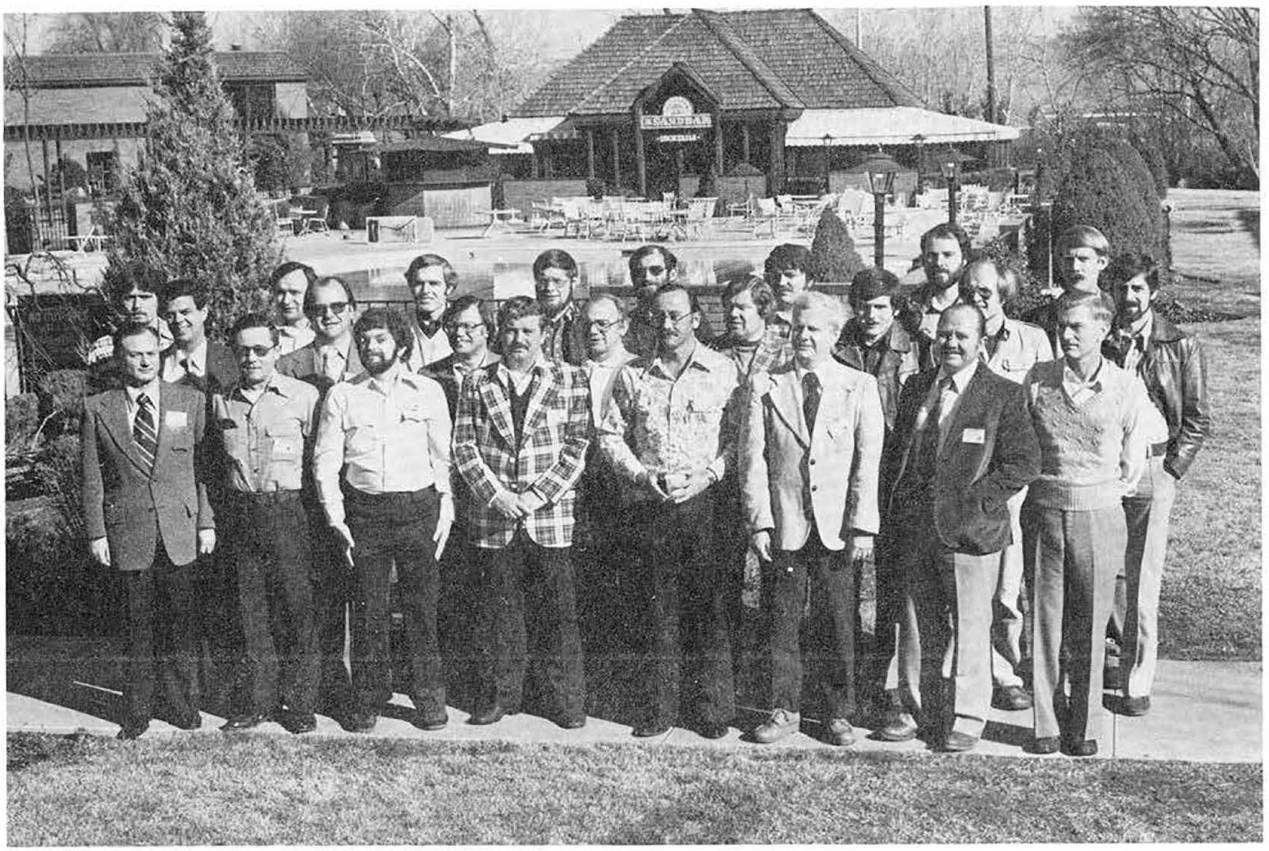


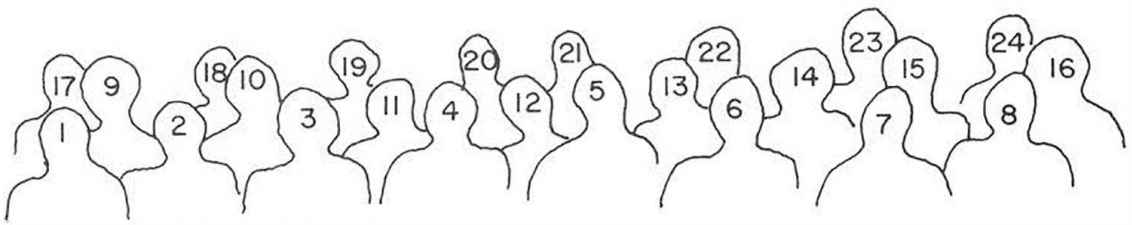


1. Paul Castrovillo
2. Bob Celaya
3. Jan Volney
4. Bob Thatcher
5. John Wenz
6. Barry Hynum
7. Dave Holland
8. Don Dahlsten
9. Ron Stark
10. Russ Mitchell
11. Paul Tilden
11A. Bill White
12. Ken Lister
13. Dave Bridgewater
14. Geral McDonald
15. Jim Smith
16. Gene Lessard
17. Scott Tunnock
18. George Ferrell
19. Peter Rauch
20. Lincoln Moore

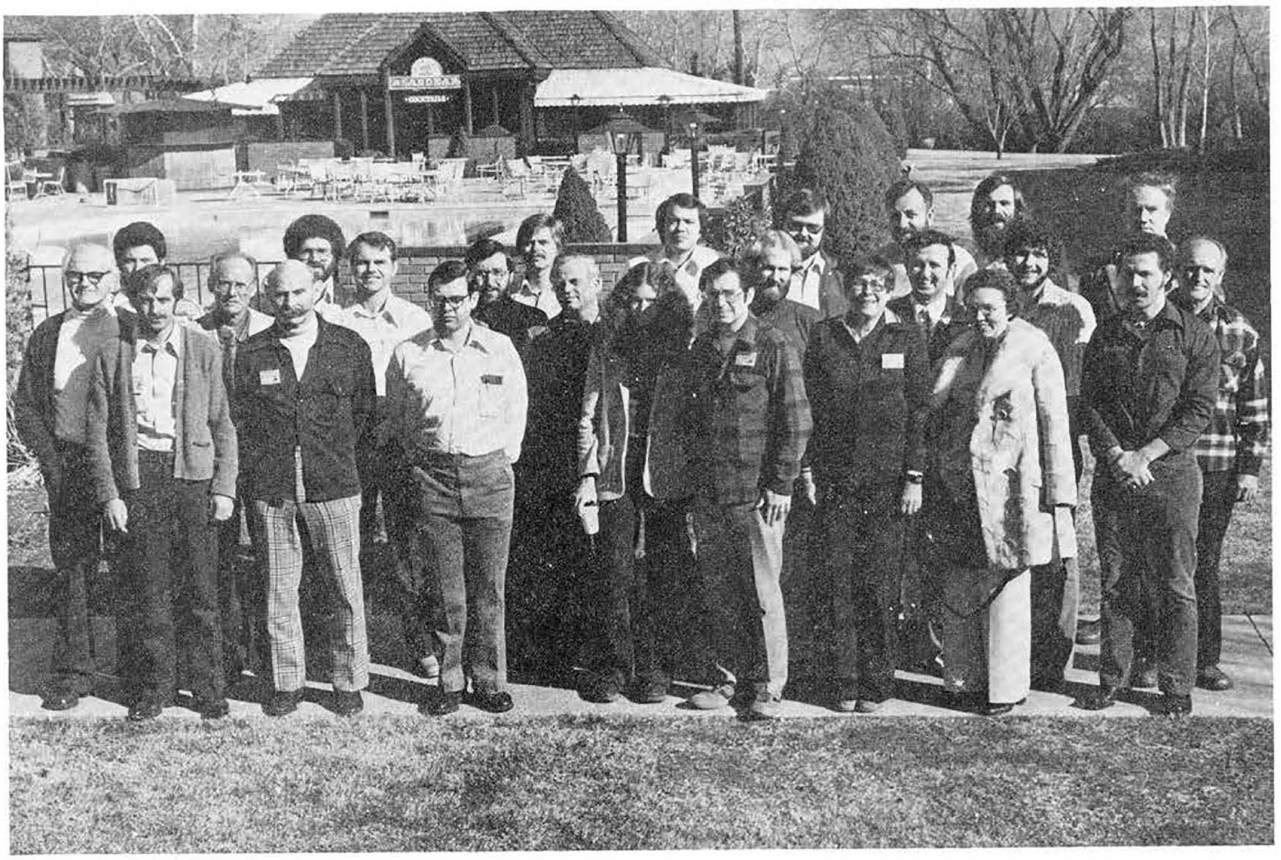


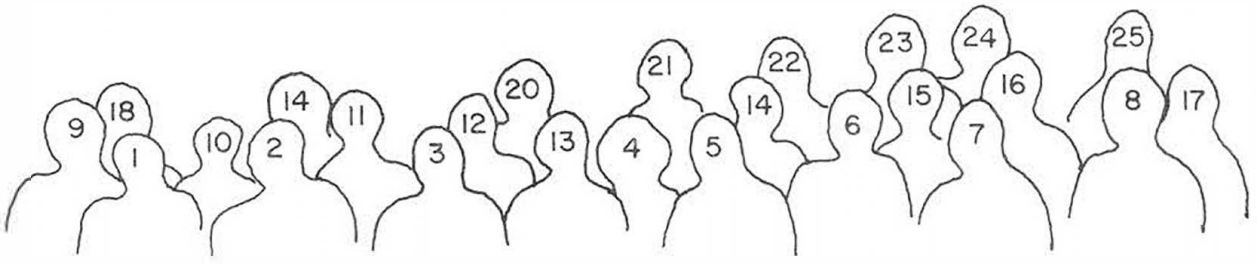
1. Dick Roberts
2. Ed Holsten
3. Max Meadows
4. Steve Kohler
5. Ralph C. Hall
6. Dave McComb
7. Bob Dolph
8. Bruce Roettgering
9. Pete Lorio
10. Dick Hunt
11. Paul Joseph
12. James Swaby
13. Kathy Sheehan
14. Jack Mounts
15. Mike Allen
16. Jack Coster
17. Jed Dewey
18. LeRoy Kline
19. Bill Ives
20. Al Larsen
21. Tom Gregg
22. Don Pierce



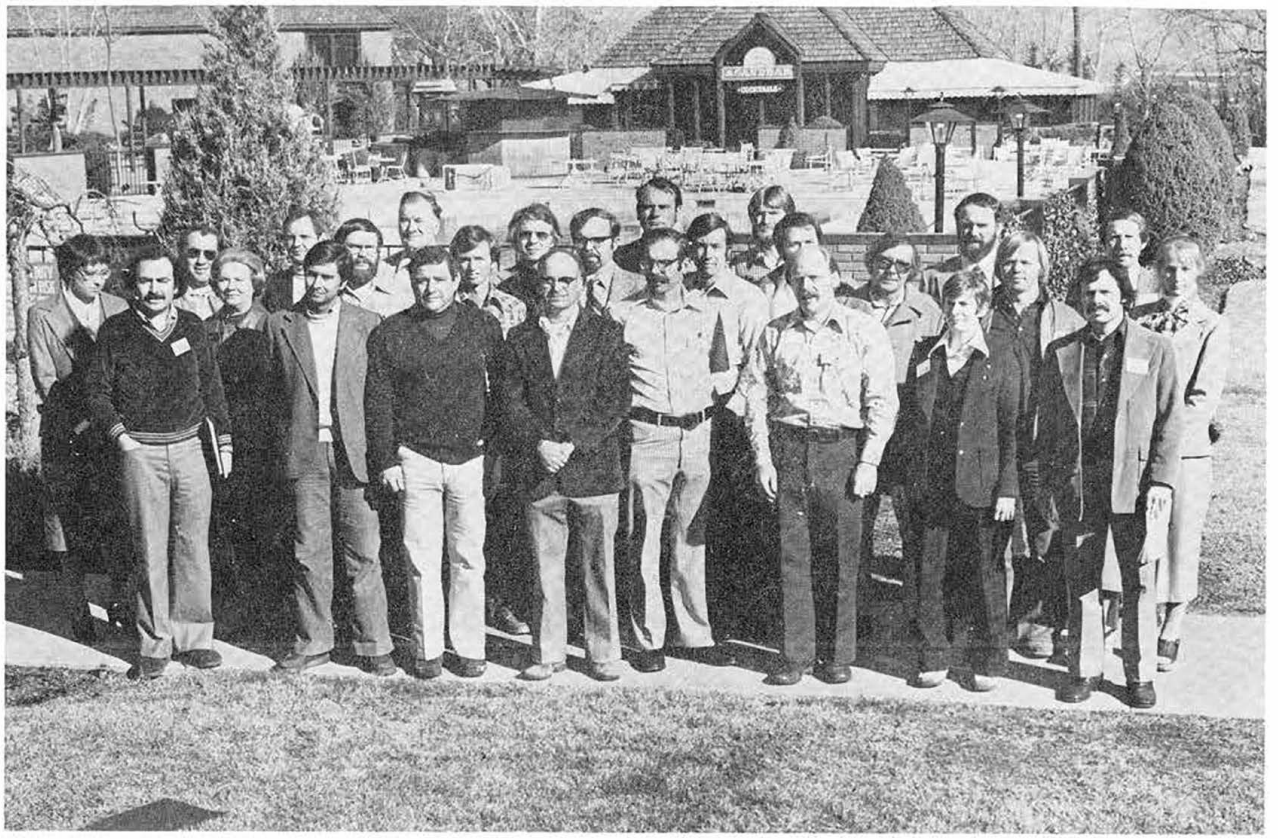


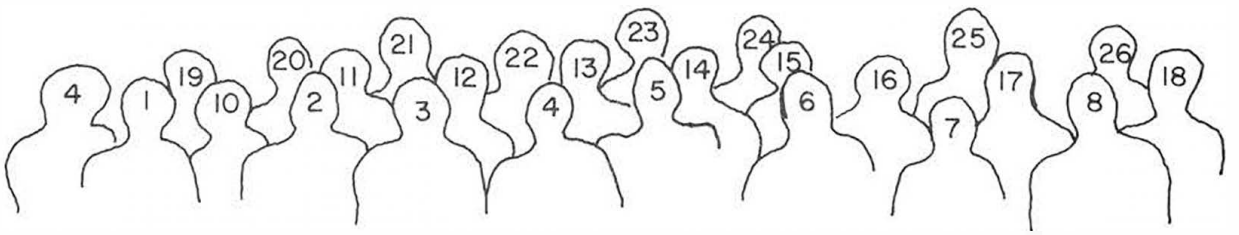
1. Bohdan Maksymiuk
2. John Schenk
3. Rich Hall
4. Pat Shea
5. Garrel Long
6. Bob Heller
7. John Pierce
8. Leon Pettinger
9. John Harris
10. Lloyd Browne
11. David Wood
12. Charles Sartwell
13. Ken Swain
14. Richard Heath
15. B. Staffan Lindgreen
16. Alan A. Berryman
17. Steve Laursen
18. Les Safranyik
19. Max Ollieu
20. Tony Smith
21. David Voegtlin
22. Mark Chatelain
23. Bob McKnight
24. Timothy Paine



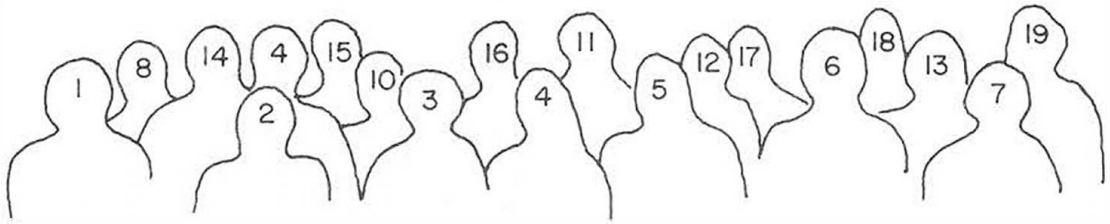


1. Lynn Rasmussen
2. Galen Trostle
3. Larry Stipe
4. Beth Willhite
5. Lee Ryker
6. Maxine Moyer
7. Carma Gilligan
8. Ken Gibson
9. Julius Rudinsky
10. George Downing
11. Allan Ballard
12. Jim Hoffman
13. Donn Cahill
14. Tom Ward
15. Mark McGregor
16. Dayle Bennett
17. Arland Valcarce
18. John McClean
19. Lyn Frandsen
20. Terry Shore
21. Dave Leatherman
22. Evan Nebeker
23. Bill Klein
24. Nicholas L. Crookston
25. Karel Stoszek





1. René I. Alfaro
2. Osvaldo Ramirez
3. Robert I. Gara
4. Wayne Bousfield
5. Ronald F. Billings
6. David L. Kulhavy
7. Mary Ellen Dix
8. Paul Gravelle
9. Molly Stock
10. Thelma Finlayson
11. Bob Averill
12. Bill Livingston
13. John Dale
14. Richard Reardon
15. Roy Dyer
16. Richard Horn
17. Dennis Page
18. Suzanne Dubrenil
19. John M. Schmid
20. Dick Schmitz
21. Mike Finnis
22. Bob Young
23. Bill Ciesla
24. Dave Johnson
25. Charles Richmond
26. Jerry Knopf



1. John A. Byers
2. A.O. "Randy" Randall
3. Gerald Wallis
4. Marita Lih
5. Fred Stephen
6. Malcolm Furniss
7. David Cibrian
8. John Witter
9. Marc Linit
10. Stu Whitney
11. Stephen L. Wood
12. David Schultz
13. William F. Barr
14. Dave Gillespie
15. Fred Hain
16. Gene Amman
17. W.G. Evans
18. Charles Tiernan
19. Marion Page

TECHNICAL PROGRAM

Thirtieth Annual Western Forest Insect Work Conference

Rodeway Inn, Boise, Idaho

March 6-8, 1979

Monday, March 5

1:00 - 8:00 p.m.	Registration
8:00 p.m.	Meeting of the Executive Committee

Tuesday, March 6

7:30 a.m.	Registration
8:30 a.m.	Conference Opening and Initial Business Meeting
9:00 a.m.	PANEL: Information Needs on Forest Pests for Decision-Making Moderator: Bill Ives Panelists: Herb Maloney Dick Dearsley Max Meadows
10:00 a.m.	BREAK
10:30 a.m.	PRESENTATIONS: Contributions of DFTM and IPM Program Outputs to Forest Resource Managers. Speaker: Ron Stark Plans to Meet the Resource Manager's Needs Through CANUSA-West Speaker: Max McFadden
11:30 a.m.	LUNCH
1:00 p.m.	CONCURRENT WORKSHOPS:

1. Managing Forest Defoliators in the West - What Strategies — Tom Hofacker
2. Getting the Forest Resource Managers' Attention, Involvement and Commitment — Dave Leatherman

3.	Role of the Host Resistance in Managing Forest Insects	Gerald McDonald
4.	Pest Management Approaches in Recreation Areas	Bob Glenn
5.	Update on Westwide Mountain Pine Beetle Survey	Bill Klein
6.	Computer Mapping: Tool for Pest Data Analysis	Bob Young

2:30 p.m. BREAK

3:00 p.m. CONCURRENT WORKSHOPS:

1.	Predicting Effects of Forest Insects on Stand Dynamics Using Prognosis Model	Nick Crookston
2.	Information Transfer to Forest Resource Manager	Jack Coster
3.	Status of Research on Low Level Populations	Dick Schmitz
4.	Influence of Management Objectives on Pest Management Recommendations	Bob Averill
5.	Update on Application Strategies for Spruce Budworm Control	Randy Randall
6.	Graduate Student Activities in Forest Entomology	Bob Loveless

Wednesday, March 7

8:30 a.m. CONCURRENT WORKSHOPS:

1.	Risk Rating Stands for Potential Pest Buildup	Ladd Livingston
2.	Forest Ecosystem Approach to Tree-Pest Interactions	Gary Pitman
3.	An Approach for Assessing Forest Insect Impacts - Recreation and Aesthetic Values	Bill White
4.	Biometrics in Forest Entomology	Carroll Williams

	5. Effect of Cooperative Forestry Assistance Act on FI & DR and FI & DM	Don Graham
	6. Aircraft Guidance Systems	Wes Yates
10:00 a.m.	BREAK	
10:30 a.m.	CONCURRENT WORKSHOPS:	
	1. Role of Silviculture in Reducing Losses to Major Western Forest Insects	Mike Cole
	2. Forest Ecosystem Approach to Tree-Pest Interaction (continued)	
	3. Aerial Application Technology	Bob Ekblad
	4. Shrub Insects	Charles Tiernan
	5. Implications of Forest Management Act of 1976 on Forest Pest Management	Bill Ciesla
	6. Making Aerial Surveys More Usable to Forest Resource Managers	Leroy Kline
12:00 p.m.	LUNCH	
1:30 p.m.	Field Trip to Boise Inter-Agency Fire Centre	
4:00 p.m.	Return to Rodeway Inn	

Thursday, March 8

8:30 a.m.	FINAL BUSINESS MEETING	
9:00 a.m.	PANEL: Importance of Forest Insect and Disease Complexes to Resource Managers	
	Moderator:	Don Dahlsten
	Panelists:	Bruce Roettgering
		John Harris
		Art Partridge
10:00	BREAK	

10:30 a.m.		CONCURRENT WORKSHOPS:	
	1.	Insecticides- Who Needs Them	Bodham Maksymiuk
	2.	Efficacy of Trap Trees in Bark Beetle Control	Dave McComb
	3.	Insect Identification Needs and Opportunities	David Cibrian Mal Furniss
	4.	International Opportunities in Forest Entomology	Bob Gara
3:00 p.m.		BREAK	
3:30 p.m.		CONCURRENT WORKSHOPS:	
	1.	Insecticides - Who Needs Them (continued)	Bodham Maksymiuk
	2.	Potential of Natural Control Agents for Bark Beetles	Stu Whitney
	3.	Insect Identification Needs and Opportunities (cont'd)	David Cibrian Mal Furniss
	4.	Genetics Research in Forest Entomology	Molly Stock
5:00 p.m.		ADJOURN	

Speakers, Moderators and Panelists - Affiliations

BOISE CASCADE CORPORATION
Malany, Herb; Horseshoe Bend, ID

CALIFORNIA DIVISION OF FORESTRY
Meadows, Max; Riverside, CA

CANADIAN FORESTRY SERVICE
Harris, John; Victoria, B.C.
Ives, Bill; Edmonton, Alta.
Randall, Randy; Sault Ste. Marie, N.B.
Whitney, Stu; Victoria, B.C.

COLORADO STATE FOREST SERVICE
Leatherman, Dave; Ft. Collins, CO

ESCUELA NACIONAL DE AGR.
Cibrian, David; Chapingo, Mexico

FOREST SERVICE, USDA
Averill, Bob; Anchorage, AK
Ciesla, Bill; Davis, CA
Cole, Mike; Bozeman, MT
Coster, Jack; Pineville, LA
Dearsley, Dick; Seattle, WA
Ekblad, Bob; Missoula, MT
Furniss, Mal; Moscow, ID
Glenn, Bob; Ogden, UT
Graham, Don; Albuquerque, NM
Hofacker, Tom; Albuquerque, NM
Klein, Bill; Davis, CA
Maksymiuk, Bohdan; Corvallis, OR
McComb, Dave; Portland, OR
McDonald, Geral; Moscow, ID
McFadden, Max; Portland, OR
McGregor, Mark; Missoula, MT
Roettgering, Bruce; San Francisco, CA
Sartwell, Charles; Corvallis, OR
Schmitz, Dick; Ogden, UT
Shea, Pat; Davis, CA
Smith, Dick; Berkeley, CA
Tiernan, Charles, Missoula, MT
White, Bill; Lakewood, CO
Williams, Carroll; Berkeley, CA
Young, Bob; Davis, CA

IDAHO DEPARTMENT OF LANDS
Livingston, Ladd; Coeur d'Alene, ID

OREGON STATE UNIVERSITY
Pitman, Gary; Corvallis, OR

UNIVERSITY OF CALIFORNIA
Dahlsten, Don; Albany, CA
Yates, Wes; Davis, CA

UNIVERSITY OF IDAHO
Crookston, Nick; Moscow, ID
Partridge, Art; Moscow, ID
Stark, Ron; Moscow, ID
Stock, Molly; Moscow, ID

UNIVERSITY OF MONTANA
Loveless, Bob; Missoula, MT

UNIVERSITY OF WASHINGTON
Gara, Bob; Seattle, Wash.

WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Executive Committee Meeting

March 5, 1979

Chairman Bill Ives called the meeting to order 15 minutes late, at 8:15 p.m. Those present were:

Bill Ives
LeRoy Kline
Jerry Knopf
John McLean
Bill Ciesla
L. Safranyik

Minutes of the 1978 Executive Committee Meeting and the Treasurer's report were read.

Chairman Ives asked Bill Ciesla to serve as Nominating Committee Chairman and LeRoy Kline to serve with him on this committee to recommend replacement for Steve Cade as councilor, whose term expired.

The Executive Committee knew of no member being deceased during the past year. If the membership knows of anyone, please inform the secretary.

The 1979 registration fees were discussed and approved. Bill Ciesla noted that Bob Acciavatti, a member of the Common Names Committee, is no longer located in the Southwest and Committee Chairman Dr. T. Torgerson needs to find a replacement for him.

The meeting sites for 1980 and 81 were discussed. Chairman Ives noted that the program chairman for the 1980 meeting should report to the membership at the initial business meeting regarding meeting site.

The meeting was adjourned at 9:00 p.m.

Minutes of the Initial Business Meeting

March 6, 1979

Bill Ives called the meeting to order at 8:50 a.m.; 20 minutes late. He welcomed the members to Boise and asked for introduction of new members. Special welcome was extended to members of the Southern and Eastern Work Conferences and the Mexican Delegation.

The minutes of the 1978 Final Business Meeting, the 1979 Executive Committee Meeting and the Treasurer's Report were read. The Treasurer reported a balance of $691.01 at the beginning of the meeting.

Gene Lessard reported on preparations for the 1980 meeting in Al Passo and Bill Ives reconfirmed the invitation to hold the 1981 meeting in Banff, Alberta, Canada.

Chairman Ives called for announcements of standing committees and special programs.

Max Ollieau reported on the theme and format of the 1979 program. He noted that, in view of the increasing size of the conference, more concurrent workshops were organized in an attempt to reduce the size of individual workshops.

Jerry Knopf reviewed local arrangements. Registration fees were set at $15.00 for regular members and $7.50 for students.

The meeting was adjourned at 9:20 a.m.

Treasurer's Report

Western Forest Insect Work Conference

March 5, 1979

Balance on hand March 1, 1978		$ 447.21
Receipts:		
Received from registration at Durango	$3,183.75 (+)	$3,630.96
Expenses:		
Ramada Inn, Durango	$1,085.15 (-)	
San Juan Tours, Durango	674.80 (-)	
Preparation of 1978 proceedings	1,180.00 (-)	
	$2,939.95 (-)	
Balance on hand, March 6, 1979		$ 691.01

PANEL: INFORMATION NEEDS ON FOREST PESTS FOR DECISION MAKING

Moderator: Bill Ives

Panelists: Herb Ives, Dick Dearsley, Max Meadows

(only the presentation "Information needs on forest pests for decision making--a federal land manager's view" by Dick Dearsley and the summary "Resource manager's needs (State)" by Max Meadows were submitted).

The problems and needs of a private land manager: Herb Malany, Boise Cascade Corp., Horseshoe Bend ID.

Thank you Bill. I have been asked to talk about the problems and needs of a private forest land manager as they relate to entomologists and how you communicate with us. Max stated in his letter (inviting me to make this presentation) and I quote, "I think it best to get this group stirred up". So if you disagree with my thoughts and opinions, capture Max tonight in some dark hospitality area and give him hell.

I am going to divide my talk into 3 segments. The first covers what the private land manager needs to make an economic decision. Second, I will discuss the information we are not getting from your group. Third, make some recommendation that may help you get through to the land manager and financial people, so we can choose an alternative action, both biologically and economically.

I will take a moment here to explain the planning process that we go through to come up with a viable logging plan. We have mills that require 50MM bd. ft. of small logs, (these are logs smaller than 16' on the small end) 45MM bd. ft. of plywood logs, (this must consist of 80% D.F. and 20% W.F.) and 105MM bd. ft. of sawlogs. Our mills are designed to operate at maximum efficiency when they receive the proper size and species of logs. These constraints allow very little deviation as to size mix. If we are out of balance we have a mill that will be out of logs or cutting logs that are the wrong size. Either event is very traumatic in dollars and cents to the operating mills, as they will be working or producing their products at a very uneconomical level and/or we cannot fulfill committments to our customers. My point is if there is a large immediate change in the raw material supply, the change being caused by a shifting in the sales program, due to some catastrophic event, either in the species composition or log size, the nature of the change can cause problems to the manufacturing units.

With this background I will begin with what the private land manager needs to know to make an economic and biological decision relating to an insect infestation on his land:

1st, what will be the immediate inpact to the logging plan and how is this going to effect the mills product requirements and other contract obligations we have? Also, we would want to start meeting with you experts to have questions answered about the short and long term effect the insects will have on our forest. The questions would go like this:
(and these are our feelings on how you answer the questions)

We will want to know how big a problem we face and what will be the long and short term effects. We need to know alternative ways the insects can be treated, plus how effective the treatment will be? What the environmental restraints will be and any other law or regulation that we should be aware of and what assistance we can be to each other?

2nd, our interests will then be directed to the impact on our forests. How much mortality will there be over a period of time, what will be the impact on the long term growth rate and what will be happening on the second forests, ie regeneration and pole stands?

3rd, then after assesing how large an impact the infestation may have on our timberlands and what methods of treatment are available, we would be ready to start determining what control method we want to procede with.

4th, lastly, we need to know the costs of different alternatives; spraying, silviculture changes in forest trees, planting, mortality, and reductions in growth rates, so we can assign economic values to these items to determine which is the most desirable alternative to follow. This economic decision must include growth and mortality reductions, profits, cost benefit ratios, etc.

Gentlemen, unfortunately to date when an outbreak occurs, all to often your answers to these questions have been we don't know. We have been spraying, smashing, cutting, and counting the insects in this country for many years and in the past have not had the necessary information to answer many of the above questions. We have some mights and maybes, but any forester who has been working in the woods several years could draw the same conclusions. I feel the expense, impacts, and public relations problems of the past can all be held to a minimum in the future by continuing the fine work done through Tussock Moth research and now the effort being put to the Spruce Bud Worm.

Now I would like to discuss the information we are getting from your people. Our company has been working with the two local national forests to develop alternative ways to control the Spruce Bud Worm. The current infestation started nine years ago north of McCall and is alive and well and has been growing. I feel this discussion could be directed to the beginning of any outbreak that has occured in the last 5 - 15 years; Mtn. Pine Beetle, Tussock Moth, and Western Spruce Bud Worm.

For my convenience, I am going to frame my discussion around the current WSB studies being done in this area. This current outbreak started in 1967 north of McCall, we watched it grow until three years ago, when it became very noticable to anyone driving on the highway. At that time a decision was made to look into the feasability of a control project. As many acres of Boise Cascade land are involved in the infested area. our interests from first hand involvement was high. Foresters from our company working with state and federal entomologists, foresters, economists, wildlife biologists, etc. have spent two years developing answers to many of the above questions. But, and this is to emphasize this presentation, while the studies went on the losses have mounted. The infestation has entered and now completely infects 20,000 acres of a company tree farm at Smith Ferry. We are suffering mortality in our baby trees and teenagers while the questions that we should already have answers for are being studied. Even though we have been studying the questions for two years (while Rome burns), some good is coming from our frustrations, I hope!

First, using a fell and buck study done on infected trees to determin growth reduction caused by the defoliation and putting this information in Al Stage's timber stand prognosis model, we can now predict the growth reduction caused by the defoliation and as a side benefit, are now suspicious that the high defect in W.F. was caused by past infestations that have opened the tree to the rot causing fungus.

A successful test was conducted this past summer with a propeler-driven, that will reduce the cost of spraying. In 1977 there were several test spray blocks that show orithene has a possible residual value or potential for holding out the SBW for more than one year.

And to the last area, and to us it is "the bottom line" for all the other tasks, and one that requires interdisiplinary discussions, was getting you etomologists, us foresters, and the economists together with everyone, converting our expertise and language to dollar and cents. This information I need as a private land manager to make a hopefully, rational decision. And I must have this information to show the bankers, financier, or legislators, so they can assess the loss or gain to enable all of us to have, or not have, a control project.

Unfortunately, to date we have not had the information available until after the epidemic has been controlled by natural means or the trees are dead. NEPA (and I'm sure you have heard of this) has completely changed the rules. As we all know, we must now have all answers when an outbreak occurs so the land manager can go through all the hoops and enact some type of treatment In a timely manner, without having to study the project for two or three years.

Now I will state some concerns, and make some recommendations of needs and pass on some observations of private land managers, that may enable all of us to do our job better. Which is to furnish society, more goods and services which are wood products at a price we can afford and recreational opportunities in a green forested setting.

I think the studies made by the Tussock Moth study team are excellant and have answers to many of the questions that are needed to implement a control project, but I think its a shame, the lack of publicity that the final report on the effects of DDT, has been given in the D.F. Tussock Moth study. Our land managers fee, if this program had been completed prior to the Eastern Oregon outbreak , only 50,000 acres would have been spraved instead of 500,000 acres that where and our company would not of had to clear , cut and plant 10,000 acres. Also, more effort must be given to reduction in growth caused by the defoliating insects, the larch case bearer, and scolitus in W.F. so their long term effects can be known. We are afraid that you people do not consider or recognize the importance of a reduction growth rate, but are mainly concerned with mortality. The studies made here on the SBW show an 18% reduction in growth, plus high mortality in the pole and sapling stand. If this reduction is spread over our whole forest - both accelerating the cut in W.F. and applying the planting costs. We will experience a 50% loss in income, and an 8% reduction in allowable cut for the lst. ten year period. The allowable cut is further reduced in the future.

I think there is a crying need for early warning, so we can make necessary changes in our programs to minimize the need for chemical solutions and the economic loss from insects. This may be obtained through use of traps or learning what silvacultural or stocking conditions invite attacks.

The national forest here is doing an excellant job of trying to head off any outbreak of Mtn. Pine Beetle, north of here. The insect is just getting a good start, following the recommendations of members of this group, who have proposed a silvaculture treatment, a timber sale, prior to having total chaos.

The land managers are afraid the research entomolgists are pulling away from chemical control due to the current political climate. This is happening at a time when the employers, manager, and financial managers of the public corporations are realizing the great potential to raising timber and the income it can generate. We find ourselves desperately in need of approved interim controls for the Bark Beetles, that can be spread safely and that will turn off the insects until we can silvaculturally treat a high risk area.

The forest service station at Moscow through Al Furness and Gary Pitman had been working with D.F. Bark Beetles, cooperatively with Potlatch, F.S., and Idaho Department of Lands, to develop an aerial application of pheremones, that is one step to fill this need.

And finally, all of us need to develop a common language so we can state the problem, give the risks, alternative methods of control, and the costs benefits that may or maynot be derived from a control so the public, our managers,and the politicians can decide what they want to do to accomplish the land owner objectives.

A Federal land manager's view: Dick Dearsley, USDA Forest Service, Seattle, WA.

I appreciate the opportunity to be here today. When Max asked me to be a member of a panel at a symposium attended by etomologists from the Western U.S. and Canada, I considered that quite an honor. Maybe a little bit more explanation on my present employment is in order. Environmental Protection Agency may conjure up some pretty nasty things in some of your minds. Basically, I'm still a Forest Service employee on loan to the EPA. My involvement is primarily in the areas of clean water and clean air--clean air from the standpoint of the implications of slash burning on the Clean Air Act, and clean water by assisting Federal land managing agencies submit to the states, and eventually to EPA, the necessary information demonstarating their commitment to meeting the Clean Water Act.

I would hope my background and experience would qualify me to talk to you about information needs on forest pests for decision making. I spend the last eight years in a Federal land manager role on two National Forests in Eastern Oregon. During that period, I was unfortunate enough to have experienced epidemics of Douglas Fir tussock moth, mountain pine beetle, western pine beetle, Douglas Fir bark beetle, and fir engraver. The most notorious epidemics were the tussock moth blowup which started near LaGrande, Oregon, and the mountain pine beetle spread that now encompasses all lodgepine stands on three N.E. Oregon National Forests. I was responsible for a Ranger District in the middle of this million acres of infestation. The District comprised arroximately 3000,000 acres, of which 1000,000 were beetle infested lodgepole pine stands. The epidemic is at such a high level that the mountain pine beetles have exhausted the lodgepole food supply in many stands and are moving into immature and mature ponderosa pine. Yes, I said mature and even overmature trees - 3 feet and greater in diameter. That damage was the thing that attracted most of the attention to some of the best stands of ponderosa pine in the country. The immediate economic losses are staggering as well as the potential loss of shelterwood trees for regenerating future crops. A year ago we were estimating several hundred million board feet needing salvage with potential damage in ponderosa pine of three times that much before the epidemic is over.

Based on my experiences with this situation, and my involvement with tussock moth and the secondary Douglas fir bark beetle problem that followed that defoliation, I'd like to suggest to you some of the entomological needs I experienced at the time and some that I have thought about later, after "brush fires" were temporarily quelled.

I've placed my needs in three categories because they are different types of need.

1. Those basic needs that relate to a situation that is already epidemic and the necessary parts of a control program.
2. Those additional needs that are more long term and relate to a prevention program and,
3. Those needs related to adequate manpower and training. First, the basic needs when the bugs are upon you.

The obvious initial information has to identify the "critter" that's doing the damage. Most of the time, this isn't a problem. However, I do recall a situation on the Malheur Forest in easter Oregon where a District ranger and his people observed several hundred acres of severe defoliation on fir trees and felt they had a localized epidemic of spruce budworm. They were contemplating a timber sale plan shift to accomodate this infestation in an attemp to try to salvage mortality. However, a closer look by our Regional entomologists revealed it wasn't the spruce budworm, it was the black-headed budworm, and as most of you know, this made a considerable difference. The activity of that insect has never been as severe as the spruce budworm and did not necessitate a strong reactive control program. By the following growing season most of the defoliated trees had recovered.

That leads me to the next thing I need. Some kind of prediction on what I can anticipate as to spread and severity. Will it end this year? Does it look like I'll be faced with it for several years? Which direction is it going? Will it involve a substantial amount of timber needing salvaging? Can I expect instant mortality, weakening from defoliation, or what?

These questions need to be answered so I can begin thinking and talking about what control measures are available. I need to know what chemical, biological or physical controls are available to me. Whether the methods being considered are chemical, biological, physical or a combination of each, it is very important the land manager obtain all the necessary information about these controls and the impacts of each. When I say impacts, I mean social and economic as well as technical and resource impacts. I feel an entomologist is the best individual to supply much of this information.

Let me illustrate this with some examples. If we are talking physical control (stand treatment or manipulation), I think the entomologist needs to be able to look at silvicultural tradeoffs so the best stand treatment under the conditions can be selected. There needs to be a concern for stand management and what we have left to manage after the control treatment. I have been a partner to treatments that left me in worse condition than if we had done nothing. This means having some knowledge of silvicultural requirements of of forest types as well as economic considerations for managing those types.

An example of economic considerations prompts me to recall the experience I had with the mountain pine beetle and lodgepole pine in N.E. Oregon. Trees were beginning to turn brown all over one end of the District. A closer look and I could see there were additional green trees with bugs in them. They were dead but didn't know it. Complete stands were infested. Almost all lodgepole pine

trees varying in diameter from 3" to 9" DBH with an occasional 10" to 12" DBH were dead or dying. The amount of lodgepole pine sold on the Ranger District up to that time was so insignificant, we lumped it with the category called WF&O (volume and price). Local mill capacities and capablilites were not capable of handling a large colume of small logs of this species. I received some top notch biological advice from entomologists on what needed to be done to get control. The biological solution was not compatible with the economic situation. The two came in direct conflict. It needed to be understood that the local mills had just absorbed about as much small material as they had ever had before in their mill yards because of the recent tussock moth salvage. We pleaded our case with industry and they responded the best they could, but we flooded the market with 25 million board feet of bug-killed lodgepole pine the first year. I remind you again the total board foot loss is now estimated at over 1 billion board feet. Obviously, it would take quite awhile to clean up the mess at a rate of 25 million per year.

The story is far from being finished. But I can report some positive progress A liquidation program of all infested lodgepole pine has begun. Even though it is in a small way, it has begun. Material is being priced and sold as chips. Utilization standards have been lowered from Regional policy for this special situation. Much work remains to be done. But giant steps have been taken since initial efforts began just seven or eight years ago. The biological needs had to be married to the economic situation before much of anything could be done. A simple fact, but necessary to understand.

A good example of the kinds of social concerns we need to be aware of was demonstrated during the great "DDT debate" of 1973-74 in N.E. Oregon. I think we learned alot about the kinds of things that are important to certain species of wildlife. We need to understand that concern and do a better job of recognizing those values. There are literally reams of statements and testimony on file in the EPA library in Seattle given during that controversy. I've thought about what that would have been like to be detailed as a Forester to EPA during that period.

One last thought on availability of control measures. Research has brought about significant changes in biological and chemical controls, The entomologist can be very helpful by being a source of "the latest information" so the resource manager can keep up to date.

In addition to what control measures are available, I need to know what's needed. Should I be thinking of more than one control measure, one by itself such as stand manipulation, or do I have an opportunity to use a couple in combination with each other?

One of the more important needs for a contorl program is information necessary for an EIS or EAR. This is an area where I feel entomologists can improve their lot. Earlier, I mentioned assisting in assessing impacts. To do this means acquiring a working knowledge of economics, some of the social issues, stand management, and an awareness of other resource considerations. There are two schools of thought on specialist input. A specialist can maintain a "purist" posture where all impacts are provided in a pure form. The decision-maker coordinates all of the information, makes the trade-offs and comes down on a decision. The other philosophy, and the one I support, involves all specialists being aware of each others impacts. The trade-offs are then identified in an interdisciplinary atmosphere. From my experience, this process produces better decisions.

Once the impacts are weighed and a decision is made as to the preferred

control program, the entomologist needs to be available for on-the-ground planning of a particular control project. Obviously, he or shee needs to be deeply involved in planning a chemical or biological control program. However, I prefer that indivadual help me with a stand manipulation project, also. The entomologist can assist with boundary identification, marking rules, contract clauses, and on-the-ground training.

And finally, the old follow through game, of which we don't do enough. Upon completion of the control program or project, I need the entomologist to return to the project area and help assess how well we did. This may involve gathering some specific data with plots or just a very subjective "look-see."

One of the most imporant concepts of all the needs I have discussed so far is the entomologist being on-the-ground with the advice, consultation and input. Some things can be done by mail or telephone, but nothing replaces in the field observation. From my own experience, this is a concept I feel very strongly about and few of you would probably disagree.

The second major category of needs I'll call the "not so basic needs." If we are ever going to get ourselves from a control mode to prevention mode, the following are things I think we need to do. Some of you may hear this and say we are already doing that or have developed that technique. Good!! I have a suggestion on how to go further with a miniumu of extra effort.

The field forester and resource manager need a "Stand Hazard" or "Susceptibility" rating system of existing timber stands prior to stands being "attacked." This system needs to be developed in concert with the field forester and should consider species, stand condition and density. Also site characteristics such as moisture and ground vegetation should be cranked in. I realize this information that can only be obtained by on-the-ground inventory. You, as an entomologist, may say, "give me the stand information for your forest and I'll build you a hazard rating." It might be that simple, but I would hope it would be a more cooperative venture. There was nothing that better maintained the atmosphere of crisis management on a Ranger District than every year revising the Five-Year Timber Sale Action Plan in an attemp to locate sales in the highest insect activity areas. We need the best predictability system you can suggest.

Also, resource managers need continual help to better recognize or sometimes just reminders of how we create ideal insect blow-up conditions with certain logging practices, timing of harvests, and slash accumulations.

I feel your discipline needs to centralize your literature storage system so retrieval is efficient and rapid. For instance, when information on the impacts of certain chemicals is needed for an impact statement or an assessment report, the wheel shoulda't have to be reinvented each time. I'm not sure what the answer is - but maybe the WestFornet system or something comparable.

My third, and last, category of needs has to do with manpower and training. Both of us, you and I, need to be able to do a better job of articulating the need for entomologists at the field level. This involves convincing decision-makers of the need for that discipline. We can't accept the philosophy that entomology was a requirement for every forester so what can an entomologist give you that the field forester can't.

Can you believe a forest with the insect problems, potential epidemics,and actual epidemics in progress such as I described earlier in my experience making a management decision that retaining an entomologist in the budget was a low priority? We did, and I was part of that ludicrous decision.

I would like to close by reiterating something I talked about earlier on. I feel the kinds of training opportunities entomologists should be seeking must deal with stand management, economics, social issues, (especially the social impacts of control programs), and an understanding of other resource considerations necessary for making integrated land management decisions.

State manager's needs: Max Meadows, California Division of Forestry, Riverside, CA.

Summary

State foresters deal with small land owners and must help them identify and solve problems on individual trees. These landowners are often urban dwellers that expect prompt response and solutions. They often have political support for their positions.

What I need can best be addressed by saying what I don't need. I don't need changes that fail to provide the same level of protection. An example:

The Southern California Maintenance Control Project has continued since the 1930's. Suddenly it was proposed by the Forest Service that we study the project. . . A process that required that half of the trees be left. . . . Political pressure stopped this study as proposed and replaced it with a study that sampled the trees but treatment of all trees continued.

What I do need are prompt solutions to problems that recognize the individual trees or small ownerships where individual trees are important. Studies won't cut it--Action is the answer in the urbanized forest.

MEETING THE RESOURCE MANAGERS NEEDS: Contribution of the Douglas-fir tussock moth and mountain pine beetle programs.

R. W. Stark, University of Idaho, Moscow, ID.

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1. USDA Combined Forest Pest Research and Development Program.

2. National Science Foundation DEB 75-04223. The principles, strategies and tactics of pest population regulation and control in major crop ecosystems combined with on-going research of the Intermountain Forest and Range Experiment Station, Ogden Utah and Moscow, Idaho.

INTRODUCTION

In attempting to outline the contributions of the tussock moth and mountain pine beetle programs in meeting resource managers needs I borrowed freely from a recent paper by Freeman (1978). I intended first to define managers needs but other than the above could not find them clearly articulated anywhere. Most such needs have been defined by pest control agencies and researchers and their concepts may be considered self-serving and open to question. From interaction with potential users of outputs from the various programs I have boiled resource managers needs down to a simple statement: specific needs will become clear during this and other workshops. The need statement is: Resource managers need information necessary to determine how unrestricted pests will affect their management goals and objectives and in theevent they do, how to either prevent or minimize pest impact.

The contribution of any pest management program can be classified under two functions of pest management: (1) to provide an information support system which responds to resource decision makers needs and; (2) to provide alternative treatment strategies which the resource manager can

live with.

Another way of assessing the contributions of tussock moth and mountain pine beetle projects to management is to consider them with relation to the steps taken in pest management decision-making a function of forest management. The two programs we are considering here pertain to two specific insects and for the MPB only in lodgepole pine.

Step 1.

Clear articulation by the resource manager of the objectives of the management unit is the first step. A pest management system is rational only if it can be related to the objectives of the landowner (Stage 1979). These objectives may be very straightforward e.g. maximum production at a set profit margin of timber or very complex e.g. to manage for a mix of resources with specific output targets such as is now demanded by the National Forest Management Act of 1976. (J. For. 1976). Researchers in particular have often ignored this plain fact, expecting resource managers to gladly endorse their elegant and complicated products and are disgruntled when they are ignored or castigated for being impractical or naive. The fault for this chasm of misunderstanding which often separates management and research lies with both.

Management asks for simplistic, unilateral and above all cheap solutions to complex ecological problems. It must acknowledge the fact that given this complexity and in todays environmentally conscious society, management must step up to a higher order (or complexity) of management planning and decision-making.

Scientists, regardless of how complex the steps needed to reach a solution must strive to reduce these to the simplest understandable essential elements and strive to make them practical and cost-effective. Scientific ego can be served in appropriate journals. There is a middle ground. Maximum efficiency at this step is enhanced if pest management personnel are involved in the planning process.

DFTM and MBP contributions to Step 1.

The two programs have made significant contributions to improving Step 1 — the most important of which is

acknowledging its importance to pest management. This was done by the inclusion at the beginning of user groups to establish clear objectives. The attendant publicity of the programs, particularly the tussock moth, the proliferation of papers articulating this basic need and the recognition of it in the drafting of regulations for the National Forest Management Act (USDA 1978) have also accelerated the process. I also like to believe that these programs contributed to the decision by the Secretary of Agriculture to issue his policy statement. (No. 1929) in December, 1977 endorsing the principles of integrated pest management.

Step 2. Identification and Detection of Pest Problems.

After clear management objectives are determined, part of the planning process should include identification of the probable pest problems which may thwart those objectives. There is always the unexpected, but I feel that this can be done in most forested areas based on historical data and present knowledge of pest population dynamics. Depending on the level of intensity of management and risk to objectives some degree of monitoring or detection survey should be incorporated into the management plan. Such detection may simply be part of a normal forest inventory procedure or through planned pest surveys such as the Canadian Forest Insect Survey used to conduct. If the former, this may require some additional training of personnel, increases in personnel or contracting. This is done at various levels of the National Forest System in some states and in progressive forest corporations, but very little is done on the vast amounts of privately owned land.

The detection process can be made more efficient if, based on historical data or the ability to determine the liklihood of any pest occurring in any particular place, the management unit can be compartmentalized into probability of risk or hazard zones.

DFTM and MBP contributions to Step 2.

Both programs provided ways to hazard-rate forest stands. Based on historical records and research it is now possible to delineate areas where there is a high probability of outbreaks occurring. Both hazard rating systems are based on information either collected routinely or easily obtained by

forestry techniques, that is, there is nothing exotic which should be strange to a trained forester. These systems permit efficient allocation of detection resources and by implication, provide guidelines for harvesting strategies to prevent future losses. The tussock moth output also provides some capability of long-range forecasting (when not where).

The tussock moth program also provides more refined methods of detection of incipient populations using simple counts of larvae from lower and mid-crown branches. These methods can be used by anyone with a minimum of training. More precise (and expensive) egg mass and larval sampling techniques are also provided which require somewhat greater expertise and are probably practical only in high risk, high value areas. Program outputs can tell the manager about the high risk of infestation; he must establish the value. A promising detection system for the tussock moth using sex pheromone may provide us with the early warning system so desired by all control and management personnel. This has yet to be tested fully during an incipient outbreak, but if successful, will provide one to two years lead time prior to the damage phase of tussock moth outbreaks.

No new detection systems have been devised for the mountain pine beetle.

Step 3. Evaluation

At the time potential pest activity is detected, the interaction between resource management and pest management becomes crucial. Evaluations must be made (1) of the probability of the pest rising to damaging numbers (biological evaluation); (2) the damage to specified resources that will result from increasing populations (impact evaluation), and (3) of the effect of the impacts on management objectives (management evaluation). The first two come from the information support system component of pest management, the third is a joint analytic responsibility of pest and resource management.

Prior state of the art generally led resource and pest managers to assume the inevitability of an outbreak and initiate control. We assumed the worst and hedged our bets, often leading to waste of funds and environmental confrontations. How much better it would be if we could assess

the probabilities with some precision and undertake only real rather than imagined problems. Both DFTM and MPB have provided some such capabilities and simulation. But, at this point we enter the land of the esoteric (science fiction as viewed by some) - computer modeling and simulation.

Contributions to Step 3.

The tussock moth program has developed a "stand outbreak model" which can be invoked at any time or at any population level. Improved knowledge of the effect of natural enemies, including the level of virus present at particular life stages in the population allow researchers to reduce the amount of uncertainty in saying - this population will continue to increase or will not. Note I said reduce the level of uncertainty. The models and the canned programs depend on certain biological, host tree and stand information which is representative of a very few stands and so presently cannot be applied throughout the range of tussock moth without additional local or regional verification. The information needed is easily collected by trained foresters or pest management consultants in the private sector and FIDM personnel in the National Forest system. Guidelines have been provided by the program for what data are necessary and how to collect them. The data are then turned over to the Methods Application Group (USFS) at Davis who are in charge of running the stand outbreak model at the Fort collins Computer Center. The resource manager need not even see the mysterious machinations of the process but it will give him greater confidence in the output if he or a staff delegate understands the process and the assumptions and knowledge upon which it is based.

The output of the model is given to the manager in terms he can understand. The effect of the possible outbreak on the mortality, tree growth, topkill and subsequent bark beetle kill. This stand outbreak model has been linked to the stand prognosis model (Stage, 1973) which translates the damage projections of the outbreak model to forest stands or aggregations of forest stands over time. The prognosis model is also based on routinely collected forest stand information for a variety of tree species (11 the last time I checked) and is capable of adding others. Again, this model is based on data from particular stands primarily in one Region and comparable data has to be used from other Regions before it can be assumed that it applies to that particular region. Again,

the output is given in terms the forest manager can understand and, being a creation of man, can be altered to a considerable extent to meet specific demands.

Remember, these models can be run whether or not an outbreak is actually incipient or in progress so that given his mix of management objectives or production targets, the resource manager can assess impact ahead of the actual event and prepare accordingly.

As mentioned above, the tussock moth-stand prognosis model combination also has some long term prediction capability — as yet untested— which coupled with stand hazard rating allows resource managers the luxury of some time for long-range planning.

The biological impacts provided by the stand outbreak model and expanded to stand or forest levels can be converted to economic terms in some instances or "product" terms in others. The TM program provided such socio-economic "translators" for timber, water, forage, wildlife production, recreation and fire hazard. I believe it is fair to say that only the timber and water models enjoy some measure of confidence. The forage, wildlife and recreation models show promise but need to be tested and refined in actual situations.

The fire model developed after the past TM outbreak flatly contradicted what every knowledgeable forester knows. That is, the model output could be interpreted to mean that there was no increase in fire hazard resulting from TM defoliation. Hopefully, the model is being changed to account for reality. The same models can be used with suitable adaptations for MPB damage.

As crude as they may be these economic models provide the basis for quantifying biological impact in resource terms so that cost/benefit or other comparisons can be made from data rather than imagination.

The MPB pest management system also provides an outbreak model coupled with stand prognosis, allowing estimation of the same impacts. It is not possible, however, to tell how far or how fast an incipient outbreak will go -- or even if it is incipient except in those areas of obvious high risk. Risk rating guidelines for determining high hazard areas

and trees are available in various easily measured ways which do reduce the level of uncertainty somewhat and which provide the forest resource manager with information upon which to plan his protection or harvesting strategies.

The information for the tussock moth is available from the USDA PNW For. & Rge. Expt. Station and/or the Methods Application Group and is soon to be available in a single document -- the famous Compendium (Brookes et al, 1979). The mountain pine beetle is less coordinated. The bulk of it is available from the Intermountain For. & Rge. Expt. Sta., Ogden Utah and Moscow, Idaho. In some information areas such as population dynamics and hazard rating different points of view are available from various universities, notably Idaho and Washington State. Both viewpoints are largely untested and both have good arguments for their points of view. These and the almost-state-of-the-art are presented in a Symposium volume soon to be available from the Unversity of Idaho.

Another word of caution. This is a rapidly moving and improving field and the custodian sources of this technology should be consulted before utilizing or implementing published recommended practices.

So-o-o-o-o the resource manager now has information on what may happen. The possible impacts have been summarized and translated into standard resource effects relevant to management objectives. The manager now has a better fix on the costs incurred should no action be taken. On the basis of this evaluation, the manager may decide to risk it, in which case he merely continues to monitor the pest situation. If the biological assessment is maybe, with some probability assigned, or yes, an outbreak is imminent or has begun, the manager still has some choices based on the results of analyzing probable impact viz-a-viz his objectives. He may decide to continue the evaluation or proceed with plans for treatment.

Step 4. Presentation and Comparison of Control Alternatives

Having decided that the risk of an outbreak is high enough and potential impact would seriously affect management objectives, the resource manager then compares the various control options available, and makes a selection and amends his management plans where necessary. To do this he needs to know: (1) treatment options and the degree to which they will

regulate the populations; (2) what effect this degree of control will have on the various impacts of the population, i.e., to what degree can his management objectives be met; (3) the costs both in dollars and cents as well as legal and social. This information is provided by pest management and/or research. Again, a word of caution. New technology, laws and social and political reactions change frequently so the current winds of change need to be examined. The best source of this information is your friendly local FIDM office or MAG -- or even the occasional University.

Contributions to Step 4.

The tussock moth program now provides three "pesticide alternatives — a nucleopolyhedrosis virus, Bacillus thuringiensis and Sevin-4-Oil, all for short term or immediate control. Two additional pesticides Orthene and Dimilin are now being considered for registration against the tussock moth. All have been tested and environmental impact data are available so that the resource manager can weigh the environmental consequences (and public reaction) as well as control effectiveness and costs. Another potential control tactic is, hopefully, being pursued. The use of sex pheromones has been tested on a limited basis with promising results. It is not considered a viable alternative as yet.

Aerial spray technology has been improved, optimum dose rate and drop size have been better defined as well as means to achieve them. An electronic "black box" has been invented which improves the precision and standardization of spray applications from aircraft.

From its forest stand and tree studies sound guidelines are available for silvicultural and cutting practices to provide long-term prevention. None of these improved techniques have been tested against a full-fledged outbreak — the insect did not cooperate. But the pest management and research people who developed and tested them have considerable confidence that they will be effective if properly used. A major contribution to pesticide application technology is the recent publication "Methods for Sampling and Assessing Deposits of Insecticidal Sprays Released Over Forests" (Barry, et al. 1978) a joint effort by tussock moth and gypsy moth programs and the Methods Application Group.

The mountain pine beetle study teams did not provide such neat packages. Several cutting strategies, however, have been proposed and their probably effectiveness improved if the knowledge gained from ecological studies, stand-hazard rating work and cause-effect research are utilized. One treatment approach is now being tested in the Intermountain Region. For details contact W. E. Cole at Ogden, Utah.

Thanks to the stand-outbreak-prognosis linkage models for both the tussock moth and the MPB, control alternatives can be simulated on the computer, providing the resource manager with short and long-term comparative data. Based on resource objectives and local regional constraints, the manager may choose one or more of the tussock moth treatments. Integration of one or more of them has not yet been tested but the technology exists, e.g., Sevin may be used in a high value recreational area to minimize aesthetic damage but the virus or B.t. may be used over larger forest tracts where appearance is less of a problem. Again, simulation can assist.

Step 5. Implementation and Monitoring

The contributions to this step in pest management decision making should be clear from the above. Almost immediately following treatment, with judicious sampling (techniques provided) the effect of the treatment can be assessed and the effects on the stand simulated by computer. Continued monitoring will permit the pest and resource managers to refine the inputs to the models for further improvement. The manager does not have to wait until the end of the season or next year; he can estimate what will happen immediately. Comparison of what will (may) happen with what does happen will enable continued improvement of the models and management.

The entire process and the information system which feeds it is highly dependent on a truly interdisciplinary approach and on computer technology. Both the TM and the MPB and other pest management programs such as the southern pine beetle, gypsy moth, western pine beetle and many in agricultural systems have shown both the need and the value of interdisciplinarity. There need be, however, some cautionary words on the reliance on modeling and computer technology. There is a reluctance on the part of many resource managers, public and private, to use or act upon the outputs of computer models. This is understandable. Less understandable is the

negative stance of many scientists.

Reluctance for use stems from lack of understanding of models and their results, tradition -- a human tendency to stick with comfortable (understood) methods and a belief that in surrendering to the new technology, resource managers are giving up their decision-making prerogatives to a group of mystics. It cannot be emphasized strongly enough that the models provided by any pest mangement system are FOR INFORMATION ONLY. Neither the models nor the fabricators of them MAKE decisions — that prerogative and responsibility continues to rest with the resource managers.

Regarding the acceptance of computer (model) outputs, a real danger exists. That danger is that we arrive at the time when there is blind and total reliance upon computer-based results. Decision-makers may find modelers a convenient scapegoat for bad decisions made from misinterpretation or misuse of computer models. Thus, the onus is on responsible resource managers to make the effort to understand the formulation of particular models relevant to resource management and planning and realize the reliability of the information they provide. An even greater responsibility rests with the modelers.

All the models mentioned above work — competent computer craftsmen made sure of that. They all, however, are based on restricted sources of data so application is necessarily restricted. They are based on assumptions, the best possible, but which may be wrong or imprecise. The responsibility of modelers to minimize or prevent misuse of their creations is clear: They must:

1. Provide a clear, unambiguous statement of the purpose of the computer model.

2. Provide a complete description of the biological, ecological and economic information necessary to describe the process being modeled.

3. Provide a thorough explanation of the model and its components and a clear separation of assumption from scientifically based conclusions leading to:

4. A description of the limitations of the model for any particular user.

Both the tussock moth and MPB modelers have done, or are continuing through technology transfer sessions, to do this.

The responsibility of the resource managers is to recognize that a new mode of pest management has arrived and to cooperate in every way possible to explore its limitations and potential. This may require retraining of existing personnel or the addition of personnel trained in the new technology.

I believe that the rapid development of modeling technology in the context of pest management systems to fruition at this time is extremely fortuituous. Later in this work conference we will explore the implications of the National Forest Management Act in resource and pest management. To paraphrase romantic coupling — the two were made for each other, and the DFTM and MPB program both made significant contributions to this liaison.

Literature Cited

Berryman, A. A., Amman, C. D. and Stark, R.W. 1978 Theory and practice of mountain pine beetle management in Lodgepole pine forests. Univ. of Idaho, College of FWR Scis. 217 pp.

Brookes, M.H., Campbell, R.W. and R.W. Stark 1979 The Douglas-fir tussock moth: A synthesis. USDA Technical Bull. 1585.

Freeman, W.L. 1978 Control planning and decision-making. IN Proc. Symposium on Dwarf Mistletoe Control through Forest Management. April 13-18. Berkeley, Calif. USDA Forest Serv. Gen. Tech. Rept. PSW-31 pp. 31-35.

USDA 1978 Combined Forest Pest Research and Development Program. Douglas-fir tussock moth program accomplishment reports. Agr. Info. Bull 417 20p.

Stage, A.R. 1979 Site and Stand Inventory Ch. 9. in Brookes, et al. op. cit.

Barry, J.W., Ekblad, R.B., Markin, C.P. and Trostle, C.C. 1978 Methods for sampling and assessing deposits of insecticidal sprays released over forests. USDA Tech. Bull. No. 1596 162 p.

Jour. Forestry 1976 The Resources Planning Act as Amended by the National Forest Mangaement Act. 74 (12) 6p.

USDA Forest Service 1978 National Forest System Land and Resource Management Planning: Proposed Rules. Federal Register Thurs. Aug. 31, Part III 43 (170) pp. 39046-39059.

USDA Office of the Secretary 1977 On Management of Pest Problems. Secretary's Memorandum No. 1929 Dec. 12. 3p.

PLANS TO MEET THE RESOURCE MANAGER'S NEEDS THROUGH CANUSA-WEST

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Canada/United States Spruce Budworm Program--West
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At the Western Forest Insect Workshop held last year, Program Leader Mel McKnight and I discussed the International CANUSA Program and more specifically, the CANUSA-West effort. At that time, the Program was barely 3 months old and it was difficult to do much more than present the Activity Schedule.

Now, a year later, I've been asked to discuss plans to meet the resource manager's needs through CANUSA-West, and I have an opportunity to present our newly revised Activity Schedule to you! But I won't.

I've subdivided this presentation into four parts. First, I'd like to review the resource manager's needs or, at least our perception of what they were a year ago when a planning workshop was held in Portland.

Second, I'd like to review CANUSA-West plans and planning strategy to meet these needs. I'll follow this with a discussion of what program management is doing to accomplish these plans and finally, a few words on how we are progressing.

What Are The Resource Manager's Needs?

At this point I'd like to refer to the planning conference that was held in Portland in 1977. In preparing for that meeting, I asked Paul Buffam, Region 6 Forest Insect and Disease Management, to develop a "white paper" that would summarize and define what Western managers wanted to see as results of the CANUSA-West effort.

Needs were identified under the following general headings:

1. Detection

2. Evaluation

   a. Biological

   b. Benefit/Cost

   c. Environmental

3. Prevention

4. Suppression

More specifically, under detection, the following needs were seen:

1. Development of keys to distinguish budworm larvae from other species of bud-mining lepidopterous larvae, and

2. development of stand hazard indices to facilitate monitoring of stands susceptible to budworm damage.

As pointed out earlier, evaluation was separated into three entities. Two needs were expressed for improvements in biological evaluations:

1. One was for a system that could be used to predict population buildup and subsequent damage several years in advance; and

2. the second was to develop a system that would predict defoliation from samples taken the previous summer or fall.

The following needs were identified to improve benefit/cost evaluation:

1. Determination of the effects of western spruce budworm defoliation on fire, recreation, esthetics, water, wildlife, and range;

2. determination of effect of defoliation, top-kill, mortality, and growth loss on stand composition and structure, crop trees, cone and seed production, predisposition of trees to pathogens, and predisposition of trees to other insects;

3. determination of rate of deterioration of trees killed by defoliation so utilization values can be considered;

4. determination of costs of prevention and suppression techniques and an evaluation of their benefits. Costs to include implementation and effects on non-target organisms; and

5. derivation of a model to evaluate economics of spruce budworm management alternatives for various land management objectives.

Two elements were pointed out under prevention--specifically, the development of a silvicultural approach. These were:

1. Development of a stand hazard rating system that would identify stands most damaged by budworm as well as stands most favorable for budworm population maintenance and expansion; and

2. Prescriptions for reducing stand hazards. This could include stand density or composition manipulation and prescribed burning.

The following needs were identified under suppression:

1. A suppression strategy that would maximize effectiveness of the suppression technique (most effective in reducing larval numbers and damage while minimizing non-target effects). Included in this item is the need to know the most effective time to treat an infestation (year of outbreak):

   (a) the budworm (life-stage);

   (b) to minimize non-target effects;

   (c) to achieve level of population reduction necessary to reduce populations below a damaging level; and

   (d) to use the lowest dosage rate for chemical and microbial insecticides that is still efficacious.

2. Development of chemical compounds that have some benefit over presently registered compounds.

3. Development of materials for use in high-use, sensitive areas (e.g., Bacillus thuringiensis).

4. Development of improved methods of applying aerial sprays including:

   (a) an aerial guidance system,

   (b) equipment that produces the most effective spray spectrum,

   (c) relative effectiveness of fixed-wing vs. rotary-wing aircraft,

   (d) optimum droplet size, release height, temperature, and humidity for maximum effectiveness and mimimum non-target effects, and

   (e) practical spray assessment methods.

5. Development of improved methods for determining spray block boundaries.

6. Identification of non-pesticidal suppression techniques that are available and practical.

Plans to Meet the Resource Manager's Needs--

The Activity Schedule, as you may recall, is a dynamic working plan for CANUSA-West. It describes each of the six targets in which the Program expects to have major accomplishments by termination in 1983. Within these targets are subtargets containing one or more Activities which can be subdivided into a number of annual events or milestones that, when attained, should result in overall attainment of that particular Activity objective. Attainment of all Activity objectives should result in attainment of the subtarget objective and so on. Attainment of objectives in Targets 1-5 insures attainment of the Target 6 objective which is development of an integrated pest management system for the western spruce budworm.

Figure 1 illustrates the planning process that CANUSA-West is using to insure a continuing feedback mechanism to program management by researchers and users. Working Group Meetings provide a forum for researchers to describe and

CANUSA-WEST

ANNUAL PLANNING PROCESS

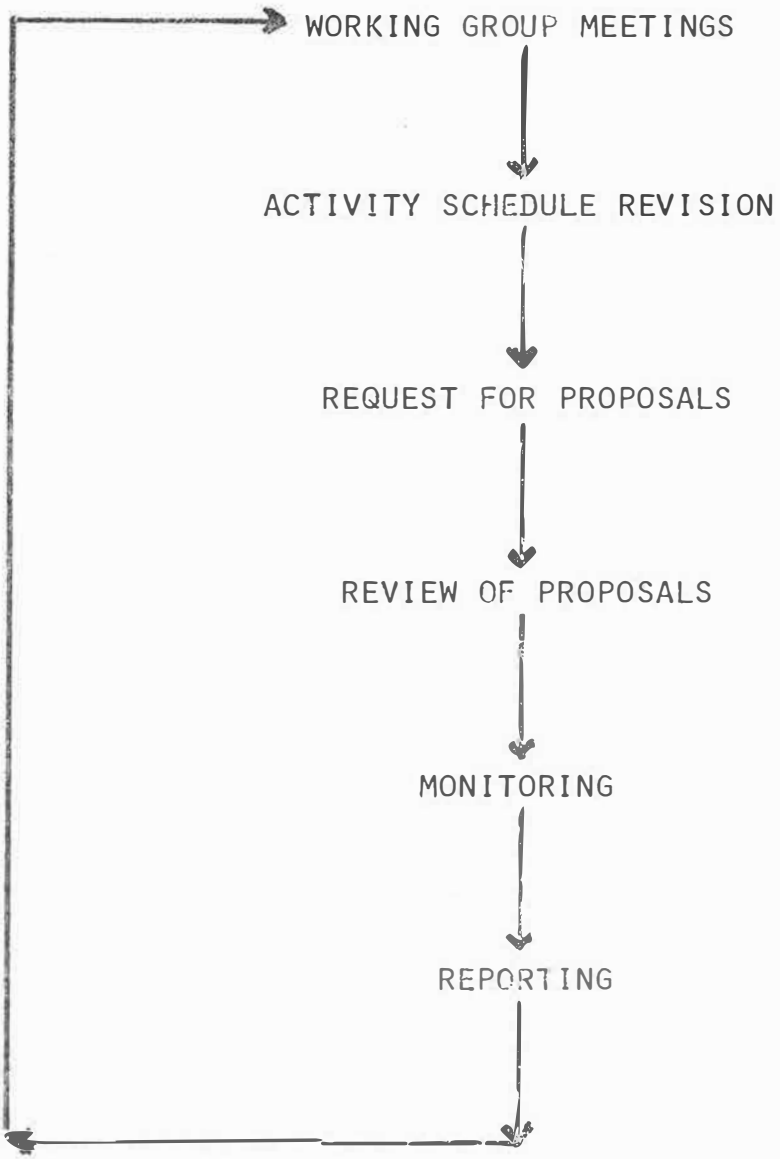


Figure 1.--Annual Planning Process.

discuss their results and for users to evaluate potential usefulness. When deficiencies in the Program are detected, the Working Groups usually develop recommendations to program management so steps can be taken to remedy the deficiency. Working Group Meetings also provide an opportunity for program management to measure annual progress in attaining program objectives and for revising the Activity Schedule to reflect that progress. This periodic revision of the Activity Schedule provides program management with an up-to-date working plan that can be used not only to measure continuing progress but also to serve as the basis for developing the following year's Request for Proposals. Again, the guidelines for proposals, which are a set of specific needs for research, development, and application work in the coming year, are usually developed by program management from Working Group recommendations and planned work as described in the Activity Schedule. Review of proposals by a Technical Review Panel composed of users and researchers provides additional guidance to program management by pointing out proposals that are most likely to meet study and program objectives and also, which are most likely to contribute to manager needs. Funded proposals are monitored by program management to insure that work in progress is directed at agreed upon objectives and is on schedule. Monitoring includes on-site visits which often lead to ideas for additional work or serve to point up weaknesses in current research planning. Investigators are encouraged to include this kind of information in written reports which are subsequently used to develop an annual report. The investigators also discuss progress at Working Group Meetings which set the stage for another feedback loop.

Figure 2 illustrates one page from the latest revision of the Activity Schedule. As might be expected, work listed under 1978 represents work carried out in that year. A blank indicates that no work was planned. Work listed under 1979 and subsequent years is an estimate of what must be done each year to attain a particular Activity objective. Needless to say, each description of work needed for each succeeding year beyond 1979 moves from expected to hopeful! Program year 1983 is not included in this table. A new feature of the Activity Schedule is the list of expected accomplishments. Admittedly, these are stated in general terms now; but with each succeeding year, they will be fine-tuned and available for manager comment.

CANADA/U.S. SPRUCE BUDWORMS PROGRAM
Activity Schedule

ACTIVITY FLOW	1978	1979	1980	1981	1982	EXPECTED ACCOMPLISHMENTS
Target 4	Chemical and microbial insecticides to suppress budworm populations and to reduce forest damage.					
Subtarget 4.1	Improve and evaluate chemical and microbial insecticides.					
Lead Array 4.1.1	Complete the development and evaluation of chemical and microbial materials now considered of high potential.	Conduct screening and bioassays for contact, feeding, and residual activity. Evaluate carrier systems in laboratory. Conduct small-scale field tests.	Complete screening of chemicals and continue screening of microbials. Continue bioassays, formulation testing, and small-scale field testing.	Complete screening, bioassays, formulation testing, and small-scale field tests. Begin pilot control projects.	Complete large-scale field tests. Continue pilot control projects. Begin registration procedures.	Complete pilot testing and registration procedures.	Registration of one chemical and one microbial.
Lead Array 4.1.2	Evaluate new, more virulent strains of *B.t.*	Laboratory screening of new *B.t.* strains.	Complete laboratory screening of new strains of *B.t.* Begin bioassay of promising candidate strains.	Complete laboratory bioassay. Begin development of new formulations of promising strains. Begin development of production techniques. Begin field trials.	Complete development of new formulations. Continue field trials.	Begin pilot testing.	Develop new strain(s) of *B.t.* for pilot test by FI&DM.
Supplementary Array 4.1.3	Evaluate new strains of viruses.	Conduct and evaluate field tests on individual trees.	Continue evaluation of individual tree tests. If warranted, begin laboratory screening.	Evaluate need for further work.			Report on virulence of new strains of viruses on WSBW.
Optimizing Array 4.1.4	Evaluate combinations of chemical and microbial insecticides.		Laboratory bioassay of microbial and chemical combinations. Identify compatible formulations.	Complete laboratory bioassay and development of formulations. Begin field testing. Start registration process.	Complete field tests and begin pilot control projects. Complete registration process.		Register one chemical-microbial combination for use against WSBW.
Supplementary Array 4.1.5	Develop and evaluate sex pheromones as control agents.	Refine controlled release formulations. Conduct small-scale field test.	Continue to refine most promising controlled release formulations. Continue field trials.	Complete refinement of controlled release formulations. Begin aerial trials.	Conduct pilot tests and begin registration process.	Complete registration process.	Register pheromones as control agents for use against WSBW.

Figure 2.--Sample Page from Activity Schedule.

How Are We Accomplishing Plans to Meet The Land Manager's Needs?

Our approach is primarily through allocation of funds. Figure 3 illustrates the actual distribution of funds in FY 1978. The shaded areas represent Forest Service base funding; cross-hatched areas indicate program funds. Target 1 includes Insect Dynamics and Survey and Evaluation. Target 2 is Stand Dynamics, 3 is Impact Assessment and Evaluation, 4 is Control, and 5 is Integration.

In FY '78, base funding was primarily directed at Survey and Evaluation in Target 1 and development of chemical insecticides in Target 4.

There are three important points to be considered in reviewing Figure 2. The first is that it reflects the first CANUSA-West Activity Schedule which had only five targets. Second, silvicultural control was included in Target 4. Third, FY '78 was not a full funding year, and funds were distributed as broadly as possible to stimulate interest in the Program while still concentrating on high priority areas previously identified by resource managers.

Figure 4 illustrates our projected funding with FY '79 funds. Again, there are several items worthy of note. First, the distribution reflects the newly revised Activity Schedule which makes it possible to portray the increased emphasis on stand dynamics in Target 2 and assessment of impacts in Target 3, both of which are addressed to highly significant questions that managers are asking: How much damage and economic loss is being caused by the western spruce budworm and can we minimize the effects of western spruce budworm through better forest management? Also, addition of a fifth target provides for evaluation of direct control materials against non-target organisms. Finally, FY '79 was the first year of full funding for CANUSA-West.

To summarize, Figure 5 represents a conceptual model of what the eventual pest management system for the western spruce budworm might look like. More importantly, it can be used to show how managers' needs are being met. Provision has been made for Detection and Evalutation under the block identified as Western Spruce Budworm Survey and Evaluation. Benefit/Cost concerns are being met through the Socio-economic Translator. Prevention strategies are being developed through the Management Alternatives box which provides for a range of silvicultural activities that could

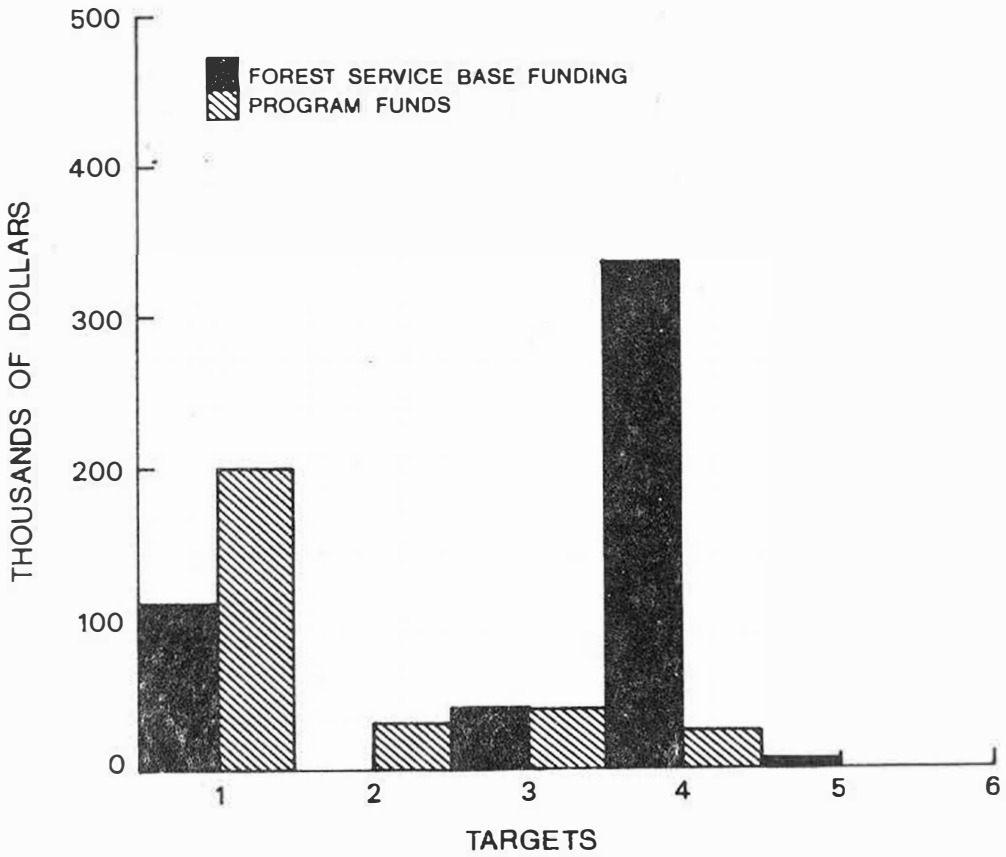


Figure 3.--Actual Distribution of Fiscal Year 1978 Funds

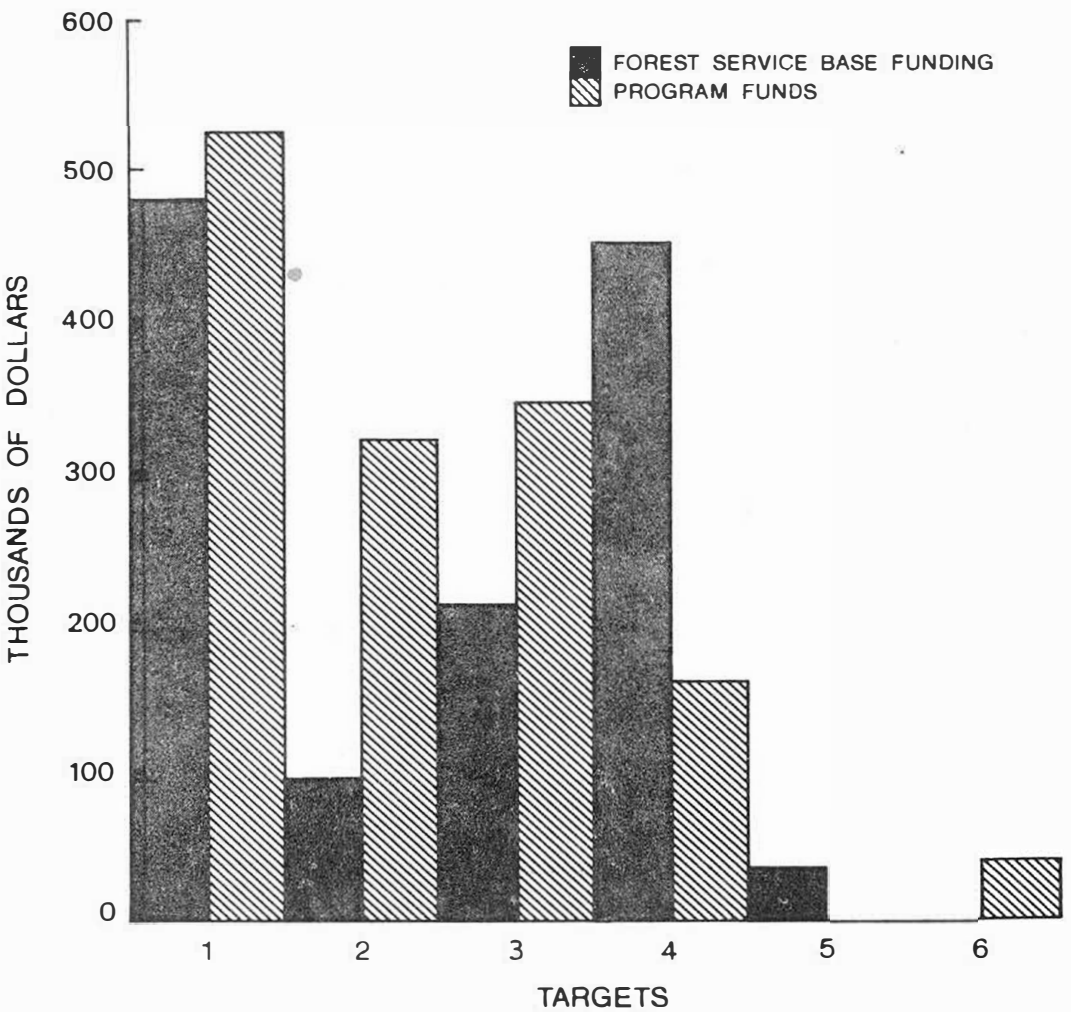


Figure 4.--Projected Distribution of Fiscal Year 1979 Funds.

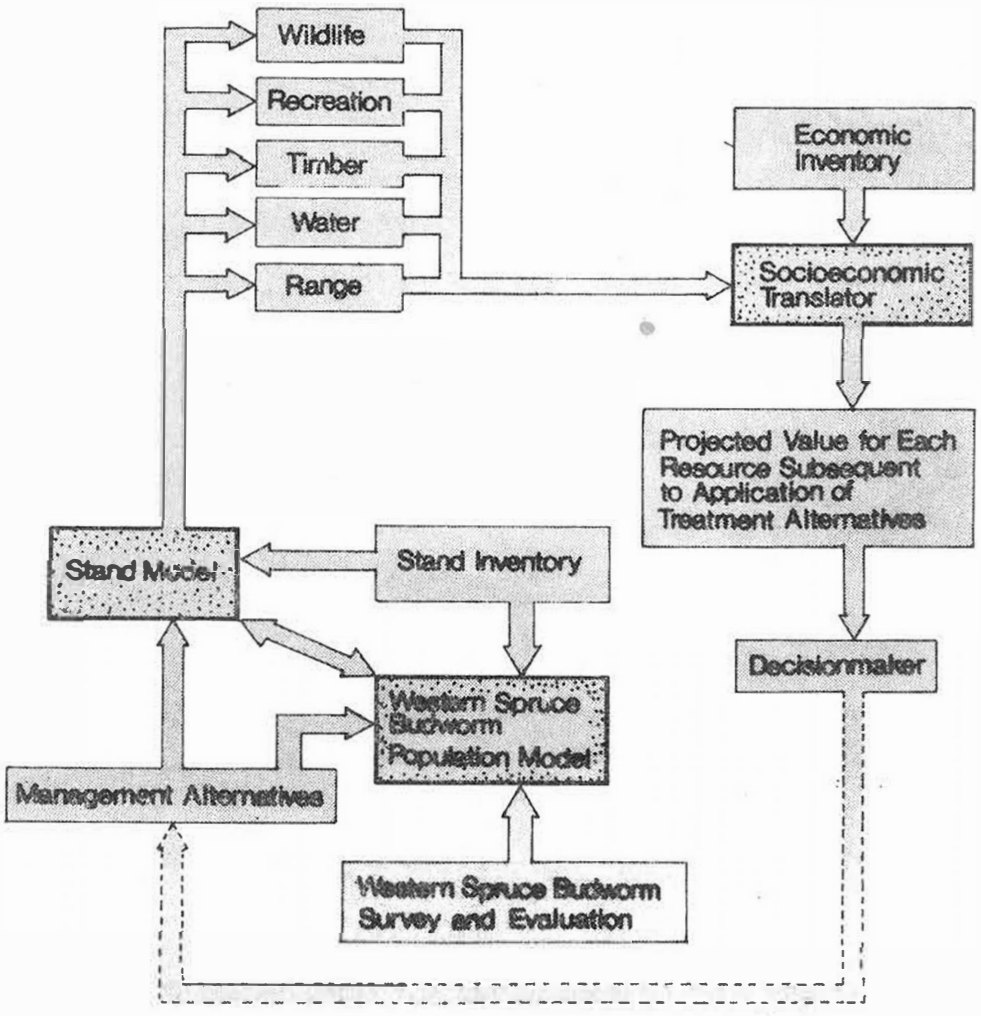


Figure 5.--Conceptual Western Spruce Budworm Pest Management Model.

influence the level of budworm damage. The same can be said for a suppression strategy where a range of direct control tactics could influence budworm numbers or degree of foliage protection.

Perhaps the most important point that I can make is this--program management has developed a planning procedure that provides continuing feedback of resource manager needs. This feedback is being used to fine-tune on-going research and development work. All Research, Development and Application work is evaluated in the context of how it will contribute to Program objectives, resource manager needs, and the proposed pest management system. The latter, of course, helps to insure that all work in the Program can be coordinated with other similar work and integrated with the total effort as early as possible.

Are we being successful in our endeavors? I'm not sure; but I do know that when we held a technology transfer meeting in Portland a few months ago, we were assured that we were on the right track.

PANEL: IMPORTANCE OF FOREST INSECT AND DISEASE COMPLEXES TO FOREST RESOURCE MANAGERS.
Moderator: Don Dahlsten
Panelists: Bruce Roettgering, John Harris, Art Partridge

During the first panel on Tuesday morning we listened to some of the needs of the resource manager. Much of the focus then and during workshops at this conference has been on single insect problems. Very seldom is a problem evaluated in such a way that other problems or a complex of insects and diseases responsible for the problem can be discovered. The resource manager rather than going out to kill a specific insect should perhaps ask the question, "Why is this insect or disease a problem?" In this way the manager may begin to focus on the cause of the problem rather than treat the symptom. This could very well be the direction for long-term solutions to our forest pest problems. This morning we have three speakers from different areas in the western United States and Canada that will give you their perspectives on insect and disease complexes.

Bruce Roettgering, Forest Insect and Disease Management, U. S. Forest Service, Pacific Southwest Region, San Francisco.

Outline of Presentation

I. Introduction

A. Forest pest complexes--definition
B. Acceptance/non-acceptance as basic working concept

II. Development (acceptance) of "Concept"--Bruce Roettgering's views from California/Forest Service perspective

A. University of California, Berkeley investigations

Smog/bark beetles
Root rots/bark beetles

B. United States and world population increases with associated demands for "forest products"

1. Shrinking land base--emphasis on other than timber (recreation, wildlife, water)
2. Legislation--Wilderness (RARE II), Native American Heritage Act, threatened and endangered
3. More people

C. Legislation--NEPA, RPA (NFMA)

III. Examples of "Importance of Concept"--California

A. Southern California Timber Management Plan
B. Laguna Mountains
C. Drought

IV. Summary

John Harris, Forest Insect and Disease Survey Group, Canadian Forest Service, Victoria, British Columbia.

Importance of Forest Pests to the Forest Manager-- The British Columbia/Yukon Experience

Land tenure in British Columbia is approximately 95% provincial, and the British Columbia Forest Service is the principal land manager. Forest research and pest surveys, however, are mostly undertaken by the federal Canadian Forestry Service. The Yukon Territory is federally managed. The wide variety of forest site types harbour many pest problems.

The historical record shows that many pests have periodically reached damaging proportions. The importance of pests to the forest manager depends on forest values; for example, once lodgepole pine was unimportant. Pests important in one area may be unimportant in another. There are a variety of pests, with new ones, even in recent years, occasionally becoming significant.

Forest managers in the past have been interested in pest problems, but seldom did anything about them. They generally were unwilling to spend money until the problem became obvious, and then it was too late. Lately, however, with forest values increasing, forest managers have shown more interest, even to the point of wanting to attempt early control of small infestations. The willingness to act has resulted in demands for predictions which, up to now, have largely been intuitive, based on survey records. The forest manager, however, now wants a diagnosis and prescription and is frustrated when timely advice is not forthcoming. But many problems are far more complicated than appear on the surface. We are dealing with one part of a complex biological situation, where each component interacts with the other: parasites, predators, weather, tree, insect. The ultimate goal is an "intelligent" model . . . one into which the forest manager can plug facts and receive answers, within specified probability limits.

One test for the importance of a pest problem to a forest manager is to threaten economic loss. Willingness to pay is a sure demonstration of interest. The provincial forest service has supported many of the federal pest surveys done in recent years. Recently, however, they have acquired two headquarters staff and some pest-oriented regional staff.

The forest manager has been involved in the multiple use aspects of forestry and now is concerned about insects he might otherwise ignore. Environmental issues, particularly those involving pesticides, have become important, as has urban forestry. Land managers other than the British Columbia Forest Service, notably from provincial parks, who formerly ignored pest problems, recently have begun to show concern.

It is concluded that we need to continue to refine our knowledge and the methods to obtain it. We cannot continue to hire more people to do the same job better. More sophisticated methods will enable the forest manager to economically assess, interpret and act upon pest problems that he encounters.

Art Partridge, Professor of Plant Pathology, College of Forestry,
University of Idaho, Moscow, Idaho.

Managing Fungus-Insect Interactions in Tree-Disease Systems

Alleviation of forest-tree problems requires that we have a clear base of reference and a clear understanding that the tree system and the fungus-insect system interact. We have reached the point of scientific maturity where we realize neither a fungus nor an insect is responsible for most tree problems. We also must realize that it is insects, fungi, bacteria, viruses, mycoplasms, nematodes and the environment that interact to cause what we call "damage." A disease does not interact. It is a response by a tree to an adverse agent. The adverse agents interact and these interactions we term "fungus-insect complexes." These complexes exist as antagonisms, associations, interactions, mutualisms, synergisms, vectoring, carrying, or metabioses. The important point is that these are systems.

Some well-documented fungus-insect systems include the interaction of Diptera in transferring sexual structures of rust fungi thus permitting completion of the fungus' life cycle. Destruction of the flies at a critical time can control some of these rusts. We also know that carpenter ants alone cause damage but when associated with fungi like Phaeolus schweintizii cause 6 or 7 times the damage incurred by either organism alone. Infested trees are then preferentially removed during stand management. Less-thoroughly documented is the introduction of Ceratocystis spp. into grand fir by Pseudohylesinus spp. with subsequent stain and canker formation.

I intend to use some of the major fungus-insect systems we have found in Douglas-fir to illustrate the potential complexity of these

systems and the potential for error of management in handling such systems. Management cannot succeed without being aware of this series of interactions and yet it is being told that the Douglas-fir bark beetle is the principal cause of damage in Douglas-fir. During 10 years of work regarding Douglas-fir mortality we have examined the entire crown, bole and roots of 380 dead, dying and healthy trees throughout Idaho. In no case was Dendroctonus pseudotsugae found alone, in many cases Pseudohylesinus nebulosus was the primary bark beetle and rarely was an insect-infested tree without root disease. The obvious root-disease organisms included Phaeolus schweinitzii, Perenniporia subacida and Armillariella mellea. But detailed analyses using cultural and microtechniques indicate additional associations between Hylastes spp. and Verticicladiella spp., the cause of root-stain disease. Overall, we found 26 stain, decay or root disease fungi associated with 14 bark beetle and borer species.

Interpretation of these implied systems gives us the tools for management. Several pathways are indicated so let's start with a common one. P. schweinitzii enters the small roots of young trees probably before they are 20 years old and very slowly destroys rootlets and the inner tissues of large roots and the lower stem. Gradually the ratio of absorptive root area to crown is reduced at which time other organisms begin to attack, particularly D. pseudotsugae and A. mellea. Almost instantly or simultaneously Hylastes spp. enter with Verticicladiella spp. Surprisingly up to 80% of the roots may be affected before this system accelerates and crown symptoms are obvious.

The implied management is multifaceted but starts with an obvious act that we all ignore. That is education. It is essential that managers know the principal parts and how they work. And I maintain that you and I, the professional entomologists and pathologists, are remiss. How many of you have written laymen's handbooks with keys to problems and generalized recommendations? Not the scientist's job you say--too easy! Well, try it and see the response you get. And remember too where your money comes from. I maintain that publications, workshops, extension visits, adult education and general information exchange are at the very heart of the problems now faced by managers in handling insect and disease problems.

This should be obvious. In the simplified system I just outlined controlling D. pseudotsugae or P. nebulosus might delay entry by A. mellea, Hylastes spp. and Verticicladiella spp. but won't prevent mortality or even save appreciable growth loss. But without your input, because nothing else is available to them, this is what most managers will try to do. Knowing that this system is common, periodic checks with increment borers can tell something about the

status of these trees before decline begins. This simple act is a vastly improved system of management. But who is trained to do it? Well, there's the second big need---field trained protection specialists on every management section of every major forestry organization in this country. The schools can do it but where's the push from you professionals and your organizations.

At the present time we are unable as a professional group to tell the public what the major forest problems are or which are causing the principal losses. Without technically well-trained protection specialists on or supervising inventories we never will.

In managing forests to alleviate disease and insect problems you will need removals, thinnings, salvages, slash disposals, special entries, etc., but I commend to you that in many cases the entries that you make in the name of control actually cause more damage than if you left the situation alone. This is particularly so where bark beetles interact with root-disease fungi. In ignorance, and with a lack of complete diagnosis who can expect to manage complex biological systems or to control by anything but accident.

WORKSHOP: GETTING THE LAND MANAGERS ATTENTION, INVOLVEMENT AND COMMITMENT

Moderator: Dave Leatherman

Panelists: Ken Lister, Mark McGregor, LeRoy Kline and Mike Fennis

This workshop attempted to cover the various techniques currently being tried to gain the attention, involvement and commitment of Western land managers. The moderator opened by stating that for the purposes of discussion the definition of land manager be kept broad: that is, not only managers who own the land they manage, but those who implement or influence the management of land owned by others.

Dave Leatherman, Colorado State Forest Service, gave a brief description of Colorado's approach to mountain pine beetle suppression, emphasizing in this case, getting the attention of landowners was not a problem. Landowners within land units selected for the program (designated control areas or DCA's) are expected to contribute labor and money to the effort. The extent of these contributions is used as a concrete measure of commitment and as a partial means of determining future government resource allocations. In 1978, the value of actual labor and out-of-pocket expenditures committed by private landowners to the DCA program was $2,084,000. Government expenditures (State and Federal) during this same period totalled $500,000. In 1978, over 170,000 MPB-infested trees were treated by all methods in 40 DCA's covering 410,000 gross acres. These trees represent 84% of those identified as needing control within DCA's.

A vigorous attempt is now underway to shift landowner involvement and commitment from short-term strategies such as direct control to silvicultural activities with potential for more long-term benefits. This is not a simple transformation in an area where non-commercial values predominate.

Once the commitment of landowners is obtained, an even harder job is sustaining that commitment. This requires perseverance and innovation ("show-me trips" via bus to demonstration thinnings, continual updating of audio-visual and other educational resources, combination of pile-and-burn beetle treatments with volunteer fire department training sessions, etc.). To be successful, the program requiring land manager commitment - whether it be a direct control

effort or one that attempts to silviculturally insulate a maximum number of acres from future beetle attack - requires constant public exposure. Over 110 winter informational meetings were held by the Colorado State Forest Service with DCA homeowner groups in 1978.

Ken Lister, R-2, U.S. Forest Service, Denver, described the Colorado Front Range Vegetative Management Pilot Project. This is a major effort begun in the fall of 1977 designed to demonstrate the multiple benefits of comprehensive forest management in a region of low-value commercial forests but with high recreational and aesthetic values.

The area encompasses some 34,000 acres of highly mixed ownership west of the City of Boulder. Approximately 44% of the area is privately-owned, 36% is USFS land, the rest being "other government." Prior to 1977 the Project area supported a large mountain pine beetle population with an associated heavy fuels build-up, and contained very few acres of "managed" forest land.

Reported accomplishments after one year's activity are: 14,028 acres require no further treatment (beetle treatment, TSI, slash disposal, fuel reduction, planting, etc., completed); 2,792 acres with TSI only completed; treatment of 74,212 MPB trees on 28,000 acres completed.

Pilot Project completion is scheduled for October 1979, with continued emphasis on implementation of silviculture activities that enhance the particular non-commercial values of this area. Emphasis will also be given to making stands more resistant to future depletion by mountain pine beetle.

Along the Front Range four new projects with similar goals are in the proposal stage. If funded, these will be known as Cooperative Management Demonstration Areas (CMDA's).

Mark McGregor, R-1, U.S. Forest Service, Missoula, emphasized the need for forest entomologists to do a better job of getting research results implemented (i.e., take a more active role with land managers than simply providing detection reports and biological evaluations). An example is the on-going project of stand risk-rating for bark beetles in Region 1. The Lolo and Lewis-Clark National Forests have been completely rated for Douglas-fir beetle, mountain pine beetle (both ponderosa and lodgepole pine types) and spruce beetle. Parts of other R-1 National Forests are in various stages of completion.

For details of this rating, see workshop summaries of "Risk Rating Stands for Potential Pest Buildup" and "Building Insect Considerations into Land Management Plans." In R-1 land managers often perform the risk rating using guidelines provided. If in the guidelines risks are put in terms of potential volume loss (i.e., made practical), managers are better able to see the utility of rating while formulating cutting schedules and other management plans.

Training provided managers by entomologists should stress not only the identity of forest pests but the "where" and "when" of expected pest losses.

The implementation of research results, and the need for field contact with managers to help insure this implementation, should be given high priority.

LeRoy Kline, Oregon Department of Forestry, Salem, began by stressing the need for decentralizing entomological personnel in Oregon. Two (regional?) entomologists have been hired and recently stationed away from the Salem Office to provide better service to field units and landowners. This is important to ensure more one-to-one contact and that entomological considerations are included during the creation of management plans. Decentralized, additional manpower also better enables the Oregon Department of Forestry to followup on management plans or recommendations. This step is often overlooked, despite its potential importance in improving the service provided land managers. How do we know our recommendations are accomplishing their objectives if we do not monitor the results of carrying them out?

Other services being provided in Oregon to help generate land manager involvement include distribution to landowners of: 1) aerial survey maps; 2) selected forest insect pheromone traps and 3) selected parasites (of the larch casebearer, for ex.). Certain large landowners are taken up in the plane during aerial detection operations and shown forest conditions first hand. Landowners are asked to monitor pheromone traps and do their own parasite releases. This personal involvement breeds future commitment by the initial participants and often creates interest in the program from neighboring landowners.

Mike Fennis, B.C. Forest Service, Victoria, stated because the great majority of forest land in British Columbia is owned by the Crown, his situation regarding the topic differed considerably from the rest of the panel. The public, being little involved in actual forest

ownership, is generally unaware of the economic need for, and dependence on, forestry in B.C. This is in part responsible for the current situation where many managers or leasees are aware of their responsibilities but unable to carry them out. Implementation of management plans which may contain provisions for a given pest is difficult because of the great diversity of pests present in B.C. Before one pest is taken care of, it is not unusual for another pest to complicate the situation.

Discussion and Questions:

The session following the panel presentation included the following questions or discussion topics:

--Who is responsible for implementation of forest risk rating in B.C.?

--How do we get around the age-old timing problem of getting land manager attention before the occurrence of a crisis to prevent that crisis? (Included in the discussion was "how do we get funded to prevent a crisis?")

--How do we define management and/or land manager?

--Actual steps needed to perform risk rating.

Comment -- The workshop would have benefited from another hour of time, had this allotment been possible.

WORKSHOP: ROLE OF HOST RESISTANCE IN MANAGING FOREST INSECTS

Moderator: Geral McDonald

Participants: Larry O'Keefe, Charles Tiernan

INTRODUCTION

Some level of genetic interaction has been found in every host:pest system that has been investigated. The important questions about a specific system are (1) how much genetic control, (2) what are the inheritance patterns, and (3) how can one maintain or utilize this existing interaction?

Since Foresters have had little experience with insect resistance the workshop moderator thought it would be worthwhile to begin our deliberations with an introduction to insect control with host plant resistance in agricultural crops. Dr. Larry O'Keefe, Associate Professor of Entomology at the University of Idaho, graciously consented to supply background information. A summary of Dr. O'Keefe's remarks follows:

Host Plant Resistance as a Control Tactic

Definitions:

"Resistance is a form of biological control and is a cultural practice commonly used to minimize pest populations. Since it is unique in that it directly involves the physiological characteristics of the plant being grown, it is usually discussed as a separate entity from the common forms of biological control involving predation, antibiosis and competition." Norton, D. C. (1975). IN State Jour. Research 49:477-499.

"Resistance in the broad sense may be considered a character of the host plant causing it to have less disease, less insect attack or less overall loss than another plant cultivar or species subject to the same attack or epidemic." Schafer, J. F. (1974). IN Proc. Summer Inst. Biol. Control Plant Insects and Disease (Maxwell and Harris, eds.). Univ. Press Miss., Jackson. 647 pp.

"Resistance of plants to insect attack may be defined as the relative amount of heritable qualities possessed by the plant which influence the ultimate degree of damage done by the insect. Painter, R. (1951). Insect Resistance in Crop Plants. MacMillan Co., New York. 520 pp.

Components:

1. Varietal resistance is definable in terms that are relative

   a. resistance vs susceptibility, the division is arbitrary
   b. immune/freedom from attack and injury
   c. tolerance/ability of a host plant to survive and yield satisfactorily at a level of infection (infestation) that would cause economic loss in other genotypes
   d. resistance and susceptibility may be identified as high, intermediate or low.

2. Varietal resistance has a genetic base - resistance is heritable and tranferable from parent to offspring. Most agricultural workers separate out pseudoresistance; induced resistance and phenological asynchrony.

3. Phenomenon of resistance is one of interaction between the host plant and pest. It has an evolutionary base/dynamic and independently evolving systems which interact.

Concepts:

1. Mechanistic concept of host-pest relations

   a. static resistance - mechanisms that are continuously "on or in" the host - regardless of whether the pest is present or not

   b. dynamic resistance - mechanisms that are initiated by the host in the presence of pests

   c. examples:

      -mechanical barriers and biophysical characters
      -hypersensitivity - sudden localized host response to presence of invaders that involves quick death of cells (accumulation of phenols) followed by isolation and death of invader
      -toxic substances, nutritional imbalance, allelochemics
      -palatability and attractiveness, biochemical factors

2. Genetic concept of resistance - two series of heritable qualities - those of the host - those of the pest

   a. specific resistance - resistance against biotypes (races) of a pest, often but not always monogenic in nature
   b. general resistance - resistance against all known races of a pest usually, but not always inherited polygenically

3. Concept of effects of resistance

   a. nonpreference (behavioral influences)
   b. antibiosis (physiological influences)
   c. tolerance

Pest Control through host plant resistance is a baseline defense.

   Economical - usually the only pest control that is "affordable" for low unit-value crops

   Environmentally Safe - at least much reduced hazards

   Excellent compatibility with other tactics

Crop Improvement is a team effort and has many components such as yield, harvestability, quality, multiple pest resistance, and general management.

Implementation:

   a. identification of resistance sources (fortuitous discovery, systematic search, mutagens, etc. - world collections, centers of origin)
   b. characterize resistance mechanisms in relation to potential for control, yield or quality losses
   c. breed R into acceptable varieties/lines - hybridization and selection - multiple characters - not easy
   d. genetic analysis of resistance traits
   e. identify chemical or physical nature of resistance in relation to pest and host plant

   Integrate with other tactics and management

Selected References for Further Reading:

Chapman, R. F. and E. A. Bernays. 1978. Proceedings 4th Insect/Host Plant Symposium. Ent. Expt. & Appl. Vol. 24.

Hanover, J. W. 1975. Physiology of Tree Resistance to Insects. ARS, 20:75-97.

Hedin, P. A. 1977. Host Plant Resistance to Pests. ACE Symp. Series 62. American Chemical Society, Washington, D.C. 286 pp.

Jermy, T. 1976. The Host Plant in Relation to Insect Behavior and Reproduction. Plenum Press, New York. 322 pp.

Maxwell, F. and P. Jennings. 1979. Breeding Plants Resistant to Insects. John Wiley and Sons, New York (in press).

Panda, N. 1979. Principles of Host-Plant Resistance to Insect Pests. Universe Books, New York. 400 pp. (in press).

Van Emden, H. F. 1973. Insect/Plant Relationships. John Wiley and Sons, New York. 215 pp.
Wallace, J. W. and R. L. Mansell. 1976. Biochemical Interaction between Plants and Insects. Recent Adv. Phytochem. Vol. 10, Plenum Press, New York.

Patterns of morphologic and insect preference of shrub species variation

Our second major problem in dealing with coniferous forests is conceptualizing variation in species that are morphologically invariate. Charles Tiernan was asked to illustrate visable variation patterns in some shrub species and to discuss bush to bush variation regarding attractiveness to various insects. A series of slides were used to illustrate the various kinds of variation.

Phenotypic variation of defoliation of Douglas-fir by western spruce budworm

Moderator McDonald briefly discussed preliminary investigations of budworm resistance in Douglas-fir. Several slides of variation of defoliation in trees with intertwined branches were presented to illustrate the degree of phenotypic variation under natural conditions and other slides illustrated survivorship patterns and crown types in collapsed outbreaks. Finally a preliminary progeny test was discussed and illustrated (See McDonald in press. Resistance of Douglas-fir to western spruce budworm: results of a preliminary progeny test. U.S. For. Serv. INT Res. Note ____).

DISCUSSION

The discussion touched on a range of topics from co-evolution of host pest systems to some specific comments about how to conduct a progeny test of Douglasfir. Some of the important points were 1) breeding for resistance to an insect pest may not be possible, 2) host-pest systems are very complex and their influence and role on the ecosystems in which they occur is very poorly understood; therefore, these systems should be studied from a holistic viewpoint, 3) should resistance to the budworm be studied from organism level of complexity (defoliation) or from the cellular (physiological and chemical) level of complexity? Other points were , 4) should beginning studies of resistance account for budworm variation as well as host plant variation, 5) Systems should be studied to learn what margins are available to capitalize, 6) the possibility of tree to tree genetic variation of insect populations should not be overlooked. A most important point to come from the agricultural experience is that knowledge about genetic interaction of host and pest has generally lead to increased effectiveness of integrated control systems for insect pests of crop plants including fruit trees; so, one should expect the same result in the case of forest trees.

WORKSHOP: PEST MANAGEMENT APPROACHES IN RECREATION AREAS
Moderator: Bob Glenn
Panelists: Jim Hoffman, Roy List, Jim Arp

Workshop Summary

Jim Hoffman - Forest Service, USDA, Ogden Utah.

"A Specialist's View of Pest Management in Recreation Areas."

The basic service offered in recreation areas by personnel from Forest Insect and Disease Management (FI&DM) is prevention. Tree losses are often reduced through the proper application of insecticides. Tree failures that threaten the lives and property of recreationists are prevented by training recreation managers in hazard tree recognition and reduction.

Many chemical controls for insects that are not economically beneficial on a Forest-wide basis can be applied for the protection of the high value trees in recreation areas. Each FI&DM unit has a pesticide-use coordinator available for consultation who is knowledgeable on the proper use of chemicals. FI&DM personnel also monitor insect populations and recommend control procedures against pests in recreation areas. National and state registration of new chemicals for use against forest insect pests is often supported by the information obtained from FI&DM pilot spray projects.

Awareness of defects in trees that may make them potentially dangerous to people or property is the purpose of hazard tree training. Recreation managers learn to recognize tree defects and value their importance with respect to public safety.

Roy List, Superintendent Operations, Boise City, Boise, Idaho.

"An Administrator's View of Pest Management in Urban Parks."

I. General.

A. Definition - a pest is something that pesters or annoys or is detrimental to man.

1. In urban park situations, such a pest is often man himself.

B. In Boise, the City as a whole has to be considered a recreation area when dealing with pests.

1. Bicycling.
2. Jogging.
3. Walking.
4. Backyard recreation.

C. Key to success is a City-wide program backed up by an ordinance.

1. All operations treat situations on an individual basis since they most often affect small portions of the population.

D. Pest management.

1. Relates to all areas of park land; turf, shrubs, trees, ponds.
2. Primary pests are in trees which are specifically under the care of the City Forestry Division.
3. Less than 10 percent of time and money is spent by this Division in parks, but these areas do get priority treatment.

II. Programs and Problems.

A. Public conflict is a potential problem on all operations.

1. Public disagrees with what we do.
2. Public disagrees with how we do it.
3. Public disagrees with public-pressure groups.

B. Pruning Program.

1. Routine, hits every park once every 2-3 years.
2. Aimed at increasing vigor, improving aesthetics while reducing habitat for pests such as elm bark beetle.
3. Biggest problem is that additional City lands are annexed yearly which creates more of a drain on the work force.

C. Planting Program.

1. Done wherever possible after removals.

2. Always done in new areas.
3. Constantly trying out species that are:
   fast growing,
   maintenance free,
   disease free,
   insect free,
   attractive,
   drought resistant,
   inexpensive,
   withstands poor soils,
   large enough to withstand vandalism.
4. As yet, we haven't found the ideal tree.

D. Removal Program.

1. Hazard reduction.
2. Species change prior to disease.
3. Understory plantings.
4. Construction projects.
5. Disease/insect.
6. Deformity.
7. Problems include public concern over any removal, public desire for firewood, disposal problems of diseased woods, clutter on City streets.

E. Insect Control.

1. Dutch Elm Disease - total program spray, prune, remove.
2. Elm leaf beetle.
3. Spruce gall aphid.
4. Mosquitoes.
5. Aphids.
6. Mites.
7. The first problem is finding staff to correctly identify the problem and solution.
8. Timing for spray operations is often frustrating due primarily to weather.
9. Money to equal increasing costs of spray materials, labor and equipment.
10. Public concern/education relating to use of chemicals in the air around them.
11. Staff turnover and training.
12. Safety requirements.

F. Needs.

1. Always a need for research. We should always be looking for more effective, safer and cheaper ways of doing things.
2. More systemics.
3. Plenty of Federal money for planting projects but little to care for existing urban forests.
4. Prevention in the form of better trees, better care for existing trees.
5. Constant dialogue and education with public.

Jim Arp - Forest Service, USDA, Payette, Idaho.

"An Administrator's View of Pest Management in Rural Recreation Sites."

The first question is, "Are Forest Service policies and procedures being followed and are they adequate?"

If safety is the key word, then the interpretation of safety is the key.

I have interpreted safety to pertain to potential hazard trees and/or hazard tree removal in existing developed recreation sites. It is my feeling that there are adequate policies and procedures in the Forest Service Manual.

The 2300 Recreation Management Manual has the following policies and procedures:

2330.2 - Objective. Develop and maintain safe, sanitary, etc., developed recreation sites.

2330.3 - Policies.

1. All developed sites will be kept in safe, sanitary, and attractive condition.
4. Priorities governing expenditures.
   a. Sanitation, safety, and fire protection.

2331.11a - Site Protection.

5. Thinning of overstory.

2331.11d - Hazard Elimination. Developed sites are to be located, planned, developed, and maintained in a safe condition.

2331.32 - Safety and Sanitation. Eliminate from recreation areas safety hazards, such as dangerous trees.

Inspection included in work plans - trees inspected periodically (part of R4-2300-1 form) and hazards removed.

2331.32 - Safety and Sanitation.

2. Recreation sites maintenance needs and safety.

a. It is recognized that every tree will ultimately fail unless removed.
b. Evaluate the hazard and remove where necessary.
c. Development could be removed instead of hazard.

Even though there are examples of tree failures that cause damage and/or death, I would suggest that, in most cases, the hazard trees are being evaluated and removed when and where found.

If the job is not getting done, where is the breakdown? The breakdown must be at the manager's level.

What are the manager's problems?

1. Lack of funds.
2. Low priority in a heavy workload.
3. Lack of experience and/or lack of training.
4. Mismanagement.

What are the corrective measures?

1. Communicate the need for budgeted dollars.
2. Because of public safety, priorities must be adjusted (as indicated by 2330.3 Policies).
3. Experience comes in time, but will come faster with training.
4. Mismanagement can be corrected by change.

The second part of my presentation is related to the involvement of insect and disease specialists and/or professionals into

management planning, site planning, construction, operation, and prevention. In most cases, no one person is able to retain all the knowledge available and/or needed in today's environment. Specialists have become necessary and important.

One form of management planning is closely related to the Policies and Procedures section in that priorities, budgets, and manpower have to be planned and programed. It is essential that the specialists' input be professional, reliable information because the next step is the actual project work. The long-range management planning is the land use planning process that indicates the need and locations for possible developed recreation sites. The specialists' input at this level could be only an inventory of problem areas within a larger given area. This information does not have to be as specific as at the project level.

At the site planning level, involvement and input will be site specific and will be related to the writing of design narratives and environmental analysis reports. Input is also needed to solve specific design problems. The input at this level has to be of a high quality and professional.

During project construction, the specialists should be asked to point out potential problems. At the same time, he will be asked to suggest solutions and/or changes. I would say that this level of involvement takes both book learning and field experience.

Operation and prevention involvement would be the same as that covered by the Policies and Procedures topic.

In summary, I would suggest that the specialists have to be professional, have broad field experience background, and be able to communicate with others.

WORKSHOP: UPDATE ON WESTWIDE MOUNTAIN PINE BEETLE SURVEYS
Moderator: William H. Klein
Contributors: Bruce Hostetler, Wayne Bousfield, Dave Bridgewater

The purpose of this workshop was to review past, current, and future surveys to measure annual mortality of lodgepole pine and ponderosa pine caused by the mountain pine beetle, Dendroctonus ponderosae Hopkins.

The Methods Application Group (MAG) in Davis, California, has been assigned the responsibility of designing and implementing surveys to measure annual mortality of forest insects and diseases on a statewide basis. As a start, MAG, in cooperation with three western Regions, conducted pilot surveys during 1977 and 1978 to measure annual mortality of the mountain pine beetle in lodgepole and ponderosa pine. The 1977 surveys were conducted in lodgepole pine stands on the Targhee National Foest, Idaho, and in ponderosa pine stands on the Black Hills National Forest, South Dakota and Wyoming. The 1978 pilot surveys were undertaken in infested lodgepole pine stands on the Beaverhead and Gallatin National Forests, Montana, and again on the Black Hills National Forest.

The basic survey method used was a multistage sampling utilizing aerial sketchmapping, large-scale (1:6000) color aerial photography, and ground truth to correlate ground counts with those made on the photo transparencies. The Targhee survey was discussed during the 1977 Western Forest Insect Work Conference in Durango, Colorado. In addition to these conventional multistage surveys, high elevation reconnaissance photography was taken during 1978 over mountain pine beetle outbreaks on the Beaverhead, Gallatin, Flathead, and Lewis and Clark National Forests, Montana, and the Black National Forest, South Dakota and Wyoming. This photography was taken during late July and early August from an altitude of 65,000' with a KA80A panoramic (optical bar) camera from U2 aircraft. High-definition Aerochrome SO-131 color infrared film was used for all missions. Efforts are underway now by MAG, the Northern Region (R-1) and the Rocky Mountain Region (R-2), and the Nationwide Forestry Applications Program (NFAP) to evaluate this imagery as a medium for direct sampling of mountain pine beetle mortality. During early 1979 MAG and R-1 will be evaluating the Beaverhead-Gallatin photography while NFAP and R-2 will be working with the Black Hills photography.

The 1977 Black Hills survey and the two 1978 surveys will be presented by Bruce Hostetler of R-2 and Wayne Bousfield of R-1. In addition, Dave Bridgewater of the Pacific Northwest Region (R-6) will discuss that Region's plans to measure mountain pine beetle-caused mortality during 1979 on the Wallowa-Whitman and Umatilla National Forests.

Ponderosa Pine Mortality Surveys In the Black Hills

The mountain pine beetle *(Dendroctonus ponderosae* Hopkins*)* has been a serious economic pest of ponderosa pine *(Pinus ponderosa* Laws.*)* in the Black Hills of South Dakota and Wyoming for as long as records have been kept (Boldt and Van Deusen 1974). During 1977 a pilot multistage survey designed to estimate annual ponderosa pine mortality caused by the mountain pine beetle was conducted in the Black Hills of South Dakota and Wyoming (Hostetler and Young 1979a). Results of the 1977 survey were not statistically acceptable necessitating a survey in 1978 with significantly modified sampling procedures (Hostetler and Young 1979b).

A stratified two-stage sampling design was employed in the 1978 survey. Stratification was accomplished utilizing information obtained from aerial sketchmapping. The area was segregated into three strata based on the estimated number of faders (i.e., ponderosa pine infested in 1977) per acre:

Stratum 1: < 0.1 faders/acre

Stratum 2: 0.1 - 0.3 faders/acre

Stratum 3: > 0.3 faders/acre

Stratum 1 was excluded from further sampling based on its low level of mortality. The significant infestation area was confined to strata 2 and 3 with 302,983 acres (122,616 ha).

In first stage sampling the primary sampling unit (PSU) was a 90-acre (36.4-ha) photo plot. A systematic random procedure was used to select 109 and 77 plots from strata 2 and 3 respectively. Sample allocation for the first stage follows:

Stratum	Size of Stratum (acres)	Size of Photo Plots (acres)	No. of PSU's	No. of Samples	Sampling Fraction
2	222,554	90	2,473	109	.044
3	80,429	90	894	77	.086
Combined	302,983	---		186	

In second stage sampling 25 photo plots were chosen with replacement from first stage samples of each of the two strata using the probability proportional to size (pps) procedure outlined by Cochran (1977, p. 251). Two 2.5-acre (1.0-ha) subplots were then chosen, using pps, from each of the 25 photo plots of each strata. The 100 2.5-acre subplots selected were ground-checked during September and October, 1978.

Data analysis consisted of (1) generating the number and volume of annual ponderosa pine mortality and (2) determining the relationship between photo interpreter counts of faders and counts of faders made on the ground.

The total number of faders estimated was 318,417 from 302,983 acres (122,616 ha) with an associated volume of 5.6 million cubic feet (1.5×10^5 m^3) (Table 1). Relative sampling errors were 4.5 and 7.2 percent for number and volume of faders respectively. These relative standard errors are at levels which are acceptable for management purposes.

Numbers of faders determined from ground counts and from photo counts were highly correlated for both strata 2 and 3 with coefficient of determination (R^2) values of 0.96 and 0.90 respectively. Combined data from these two strata showed an R^2 value of 0.93 (Figure 1).

The multistage sampling design using pps for second stage sample selection seems to be a practical and efficient procedure for estimating beetle-caused tree mortality (Hostetler and Young 1979b). Sampling errors for the 1978 mortality survey are significantly lower than those of a similar survey conducted in 1977 (Hostetler and Young 1979a). Reduced sampling errors in 1978 were largely the result of selecting stage two samples using pps instead of using a random selection procedure as was used in 1977. The pps procedure greatly reduced the probability of selecting stage two samples which contained no or very few faders.

The multistage survey methods used were successful in estimating ponderosa pine mortality caused by mountain pine beetle in the Black Hills. Even though the area surveyed contained predominately pure ponderosa pine forests, these survey methods should, with some modification, be successful in forested areas containing ponderosa pine mixed with other tree species.

REFERENCES CITED

Boldt, C. E., and J. L. Van Deusen. 1974. Silviculture of ponderosa pine in the Black Hills: the status of our knowledge. USDA For. Serv., Rocky Mtn. For. and Range Exp. Sta., Res. Pap. RM-124, 45 pp.

Cochran, W. G. 1971. Sampling techniques. 3rd ed. John Wiley and Sons, Inc. New York, NY.

Hostetler, B. B., and R. W. Young. 1979a. A pilot survey to measure annual mortality of ponderosa pine by the mountain pine beetle in the Black Hills of South Dakota and Wyoming. USDA For. Serv., Rocky Mtn. Region, Tech. Rep. R2-15, 20 pp.

Hostetler, B. B., and R. W. Young. 1979b. Estimation procedures for determining annual tree mortality caused by the mountain pine beetle *(Dendroctonus ponderosae)*. USDA For. Serv., Rocky Mtn. Region, Tech. Rep. R2-20 (In preparation).

Table 1. 1978 multistage estimates of numbers and volume of *P. ponderosa* infested in 1977 by *D. ponderosae* in the survey area of the Black Hills of South Dakota and Wyoming.

Stratum	Area (acres)	No. of faders	Standard error	Percent error	Volume per tree (cu. ft.) [1/]	Total volume (3 M cu. ft.)	Standard error	Percent error
2	222,554	182,748	10,985	6.0	18.7	3,422	331	9.7
3	80,429	135,669	9,299	6.9	16.3	2,207	238	10.8
2&3	302,983	318,417	14,392	4.5	17.7	5,629	408	7.2

1/ Volumes were calculated using information from Table 1, page 5 of: Meyers, C. A. 1964. Volume tables and point-sampling factors for ponderosa pine in the Black Hills. USDA Forest Service, Rocky Mtn. For. and Range Exp. Sta., Res. Pap. RM-8, 16 pp.

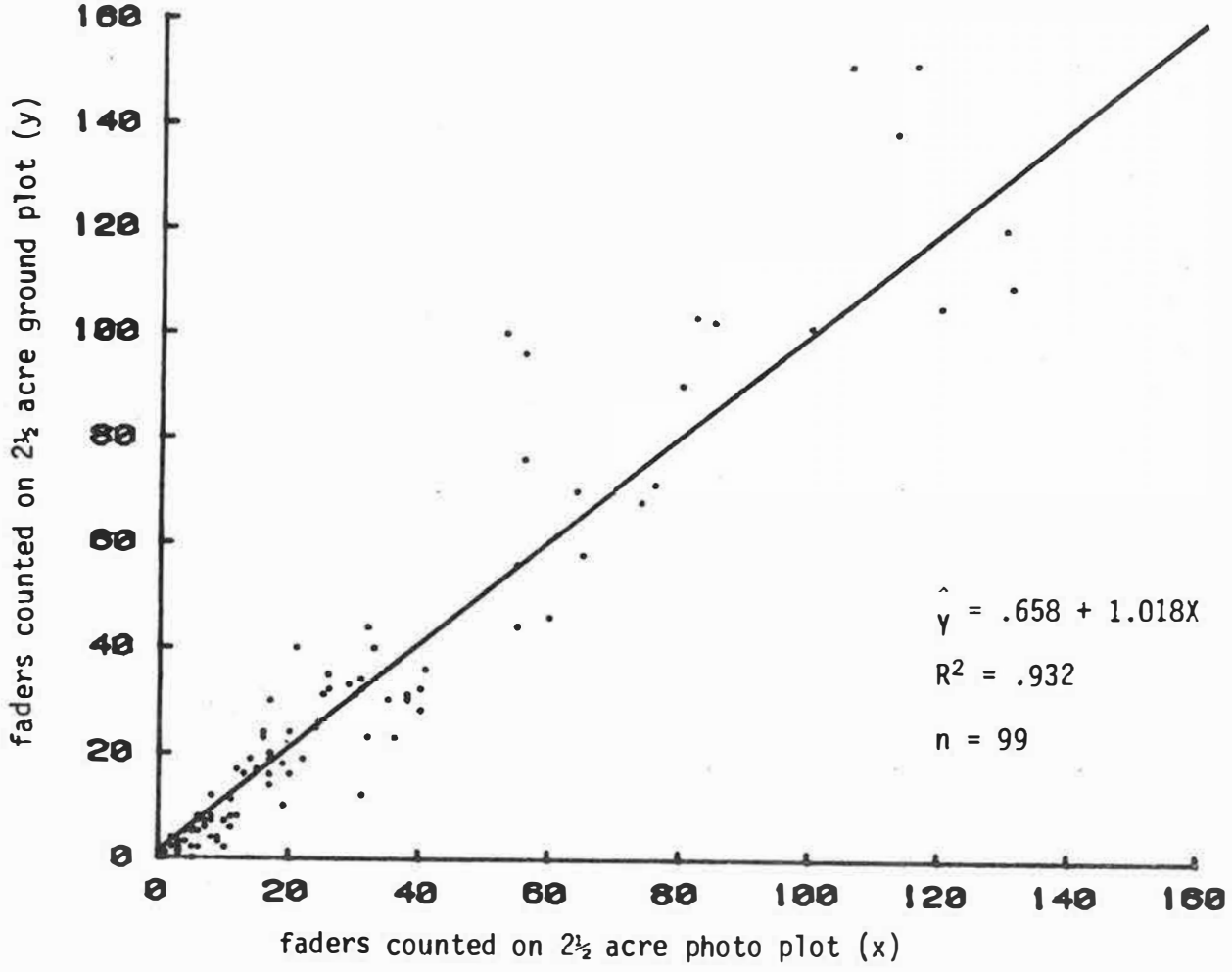


Figure 1. Photo and ground counts regression, combined data of strata 2 and 3, Black Hills of South Dakota and Wyoming, 1978.

Surveys in Montana

In R-1 both optical bar U2 color IR photography and conventional true color, 1:6000 scale, were obtained on the Gallatin and Beaverhead National Forests in 1978.

There were contractual problems securing the 1:6000 color photography taken on a sample basis, and so the film was not obtained in time to complete the ground truth. The photo interpretation was done on sixteen 2½-acre cells covering 40 acres on each stereo pair; ground truth will be done this spring.

MAG will complete the evaluation of the U2 coverage.

Next year R-1 plans to do a complete statwide survey for mountain pine beetle in lodgepole pine. Five major areas will be covered for the State of Montana.

R-6 Plan for a Mountain Pine Beetle Survey in 1979

Since 1967 there has been an outbreak of mountain pine beetle in the Blue Mountains in northeast Oregon. The outbreak area covers 1.6 million acres and the beetle has killed an estimated volume of more than 1 billion board feet of lodgepole pine.

As Ron Stark said in the morning session, there is a need for updating the lodgepole growth and mountain pine beetle predictive models for different geographical areas.

R-6 is proposing a loss assessment survey during 1979. The objectives of this survey are to: (1) calibrate the lodgepole pine growth prognosis model for the Blue Mountains; (2) assess the losses caused by the mountain pine beetle in the Blue Mountains; (3) check if the mountain pine beetle outbreak model predicts these losses; and (4) if needed, calibrate the mountain pine beetle outbreak model to the situation in the Blue Mountains.

The survey will utilize the standard R-6 stand exam plus collecting data on phloem thickness and habitat type. Three areas will be surveyed: (1) green areas (without mountain pine beetle), for the growth prognosis model; (2) active mountain pine beetle areas for progression of the outbreak; and (3) dead areas where the beetle is no longer active for the loss assessment.

WORKSHOP: PREDICTING EFFECTS OF FOREST PESTS ON STAND DYNAMICS USING THE PROGNOSIS MODEL
Moderator: Nicholas L. Crookston
Speakers: Albert R. Stage, Robert A. Monserud, Donald G. Burnell, and Dave VanDeGraaff

INTRODUCTION

One of the key elements of information needed by forest planners is a set of timber yield tables applicable to the forest for which they are preparing a plan. These tables contain statistics which describe the predicted yield of the stands in a forest as if they were being managed under each of several contemplated regimes. The availability of accurate yield information greatly enhances the basis for developing optimium management plans and for making economically significant management decisions.

Phytophagous forest insects can alter the course of stand development and thereby greatly impact the optimium management plan for a forest and hence the forest's expected net value.

About 35 attendees heard how the stand prognosis model (Stage 1973) can be used to develop yield tables where Douglas-fir tussock moth and mountain pine beetle are important. In addition, the use of the model for developing yield tables for the western spruce budworm outbreak areas in central Idaho was presented. The use and importance of yield information in management planning was also addressed.

Albert R. Stage: Stand Prognosis Model--The Central Link In a Decision Support System for Forest Managers

The prognosis model for stand development is part of a system for supplying information about timber resources needed for scheduling forest management activities. Special emphasis is given here to decisions concerning treatments that affect pest populations - either directly through pesticides or indirectly through the dynamic interactions among populations of hosts and pests. Implicit in this decision process is that a choice from among alternative schedules of activities will depend on comparison of expected consequences, i.e., from comparing the predictions of how the future would appear if each of the alternative activity schedules were to be adopted. When the system to which the activities are to be applied is a complex forest ecosystem, the manager needs extensive assistance to develop the predictions. The talents, information, and

facilities for providing this assistance have been termed a decision-support system.

The goal of the decision-support system is to help the manager plan a schedule of activities, which, when followed, are expected to meet the specified goals of management within the limited resources available to the manager. For a silviculturist, the activities might include regeneration harvests, thinning, cleaning, release from competing vegetation, site preparation, planting and other cultural activities. The goals to be met might include production of timber products, enhancement of wildlife habitat, or maintenance of aesthetic appearance, all within a given budget and work-force.

The decision support system for forest management consists of procedures for five segments of the planning process. These segments, in sequence are:

1. Define range of treatments that are to be considered.

2. Inventory the resources that are to be considered.

3. Predict the consequences of performing the treatments on the resources.

4. Choose the schedule of actions that most closely meet the specified goals.

5. Monitor the actual results of the treatment.

The manager/decision-maker plays a very important role in the design of a decision support system, and hence, of response models. Two tasks are inescapably required of the manager. First, he must define clearly what attributes of the future status of the ecosystem will directly influence his decision. To use a motion-picture analogy, the manager must specify whether he requires a slow-motion telescopic panning of the landscape, or whether a time-lapse wide-angle view is required. More precisely, the resolution of prognoses of particular attributes on the scales of future time and space must be specified. If the attribute is timber yield, is the manager interested in working circle totals by decades, or only in average levels of productivity over a rotation?

The second task required of the manager is to specify the range of treatments he is considering. In many cases, certain actions may be precluded by prior decisions concerning land use. Is herbicide application to be considered? Can pre-commercial thinning be included? What minimum volumes must be

available to schedule a commerical thinning? The range of activities may be limited by prior decisions, by access, or by other externalities. The key feature of this segment is that more than one set of possible actions is proposed. Choice of the best schedule of activities follows comparison of consequences for each set of actions.

To predict the consequences requires that first an inventory of the stand be obtained. This inventory becomes the input to the stand prognosis model. At each sample location in the stand, habitat type, shrub cover and height, and conifer stocking are recorded. Trees included in the sample are described by recording species, d.b.h., and crown ratio. For a subsample of the pole and larger trees, height and radial growth are recorded also. For smaller trees, a subsample of height increment replaces the radial increments measured on larger trees. Although many variations of inventory design can be accommodated, the procedures used on National Forests of the Northern Region have proved satisfactory (Stage and Alley 1972).

Features of the forest that can be predicted with the prognosis model include the conventional units of timber yield in total cubic feet, merchantable cubic feet, and board feet. In addition, other features related to wildlife habitat changes, watershed protection, and recreational value can be derived from the fundamental tree and shrub variables. Time spanned by the predictions can range from as short as a few years to as long as a full rotation.

Robert A. Monserud: The Combined Stand Prognosis and Douglas-Fir Tussock Moth Outbreak Models

The model for simulating outbreaks of Douglas-fir tussock moth (Orgyia pseudotsugata) (Colbert and others 1979) has been embedded as a series of subroutines into the model for predicting forest stand development (Stage 1973). The combined model can be used to assess the likely consequences of silvicultural and DFTM control activities for stands in the Northern Rocky Mountains (northern Idaho, western Montana, eastern Washington, northeastern Oregon), using existing forest inventories. It can be used as a tool for long-range timber management planning, because it displays the projected results of alternative strategies for the management of forests affected by the tussock moth. This integrated approach permits direct comparisons of various management and tussock moth control strategies in terms of stand volume development over time, rather than an

intermediate effect such as defoliation. The flexibility of the model has also proved valuable in examining the importance and sensitivity of various assumptions in the combined outbreak and stand model (for example, the allocation of eggs to trees of various sizes). This integrative capacity can thus be useful in pointing out future research needs.

To properly combine these two disparate models, the following submodels and algorithms had to be developed:

1. Probability of outbreak.

2. Foliage biomass classification.

3. Tree class compression.

4. Allocation of eggs (first instar larvae) to tree classes.

5. Outbreak control options.

6. Tree defoliation effects:

   --probability of mortality
   --probability of top-kill (with volume trunctation)
   --diameter and height growth loss.

Each of these features is discussed by Monserud (1978a) and in detail by Monserud (1978b).

Figures 1-4 display examples of volume development vs. time for various levels of the major input and control options available. The sample stand simulated is from Boyd Wickman's Y-Ridge plots, as measured at the beginning of the most recent Oregon Blue Mountains outbreak. Since the current version of the stand prognosis model does not yet include regeneration establishment, all simulation results reported here are based on projecting only trees and seedlings established at the start of the outbreak.

Figure 1 demonstrates the effect of increasing levels of eggs at the beginning of the outbreak, using the random egg allocation assumption. Only minor impact on projected stand volume results when egg densities average 5 or less per tree class (represented by a 1,000 in^2 sample branch). Severity increases rapidly when this average density increases to 8, with over 1,000 ft^3/acre lost in 5 years. At an average density

of 14 eggs, over 50% of the standing volume is lost in 5 years. After 50 years, volume development following the first two levels of outbreak (5 and 8 eggs per tree class) has nearly caught up with the no-outbreak volume level. However, even 50 years after the development is still 1,000 ft^3/acre behind the no-outbreak level. Obviously, insect density at the start of the outbreak can influence the stand's development far into the future.

Figure 2 compares the effect of allocating a fixed amount of eggs to trees in three different size classes. For example, the most severe reduction in volume illustrated in figure 2 was outbreak "D," obtained by allocating the largest number of eggs (11 on Douglas-fir, 15 on grand fir) to the top third of the d.b.h. distribution, and the smallest number (7 and 5) to the bottom third. When the egg densities on these two d.b.h. classes are reversed (outbreak "A"), the amount of volume lost is considerably reduced. Not too surprisingly, stand volume development can vary greatly, depending on the size of tree defoliated during the outbreak. Using overall stand averages for insect densities thus results in less precise estimates of volume development if the pest is differentiating between tree size classes.

Figure 3 illustrates the effectiveness of simulating various control measures. The "no control" outbreak curve was obtained by allocating egg densities (7, 9, 11 for Douglas-fir; 5, 10, 15 for grand fir) using the first deterministic

Figure 1.--Comparison of simulated volume development resulting from outbreaks beginning with an average of 5, 8, and 14 eggs per tree class. Eggs were randomly allocated with a standard deviation of 2.

Figure 2.--Simulated volume development following outbreaks resulting from deterministically allocating three egg densities (Douglas-fir: 7, 9, 11; grand fir: 5, 10, 15) to each third of the d.b.h. distribution; each outbreak resulted from the same total number of eggs.

Figure 3.--Volume development following various outbreak control measures applied in Phase III: Nuclear polyhedrosis virus (NPV3) and chemical controls applied early or late with 95% or 80% efficacy (CC3E95, CC3E80, CC3L95).

Figure 4.--Volume development following various salvage methods. Surviving trees with defoliation exceeding 95%, 80%, and 20% are salvaged. An additional 2,215 ft^3 in mortality is also available for salvage in 1976.

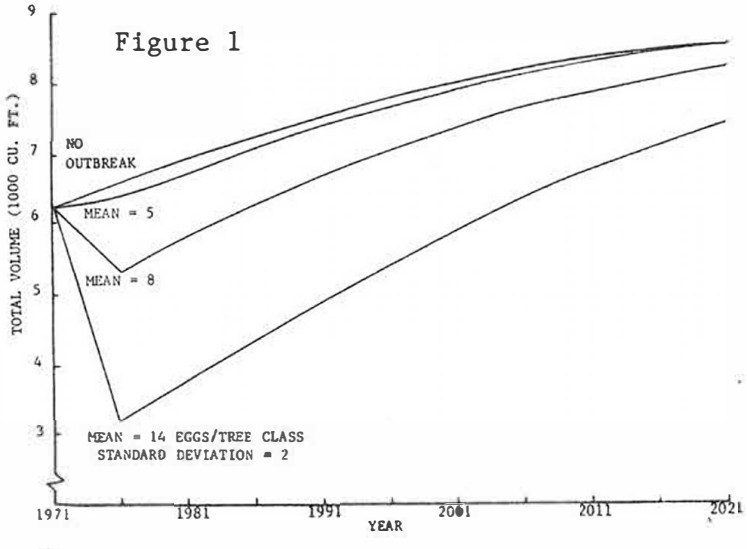


Figure 1
TOTAL VOLUME (1000 CU. FT.)
NO OUTBREAK
MEAN = 5
MEAN = 8
MEAN = 14 EGGS/TREE CLASS
STANDARD DEVIATION = 2
1971
1981
1991
2001
2011
2021
YEAR

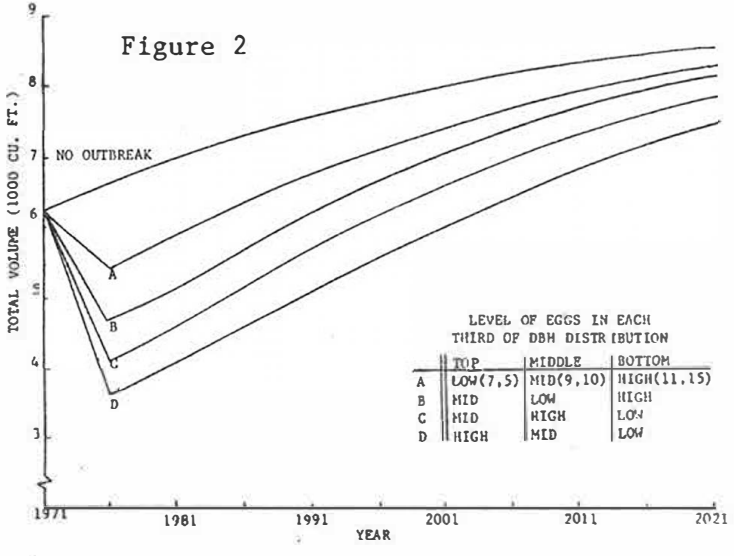


Figure 2
TOTAL VOLUME (1000 CU. FT.)
NO OUTBREAK
A
B
C
D
LEVEL OF EGGS IN EACH THIRD OF DBH DISTRIBUTION
TOP | MIDDLE | BOTTOM
A | LOW(7,5) | MID(9,10) | HIGH(11,15)
B | MID | LOW | HIGH
C | MID | HIGH | LOW
D | HIGH | MID | LOW
1971
1981
1991
2001
2011
2021
YEAR

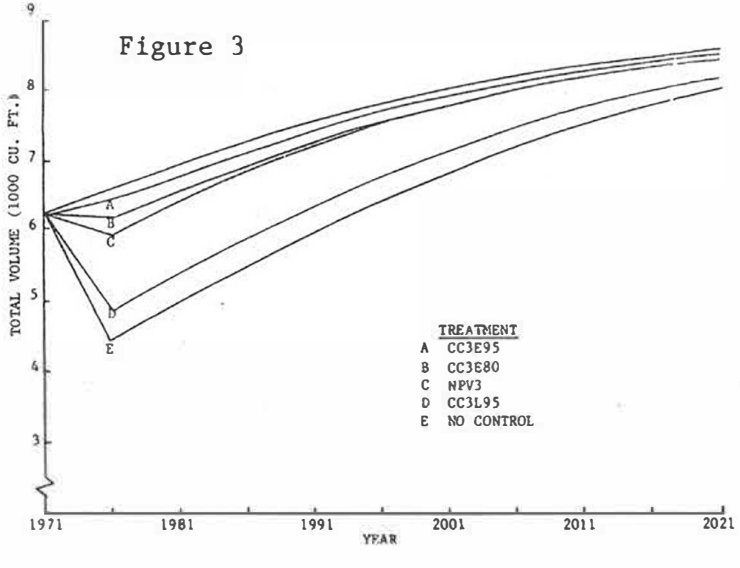


Figure 3
TOTAL VOLUME (1000 CU. FT.)
A
B
C
D
E
TREATMENT
A CC3E95
B CC3E80
C NPV3
D CC3L95
E NO CONTROL
1971
1981
1991
2001
2011
2021
YEAR

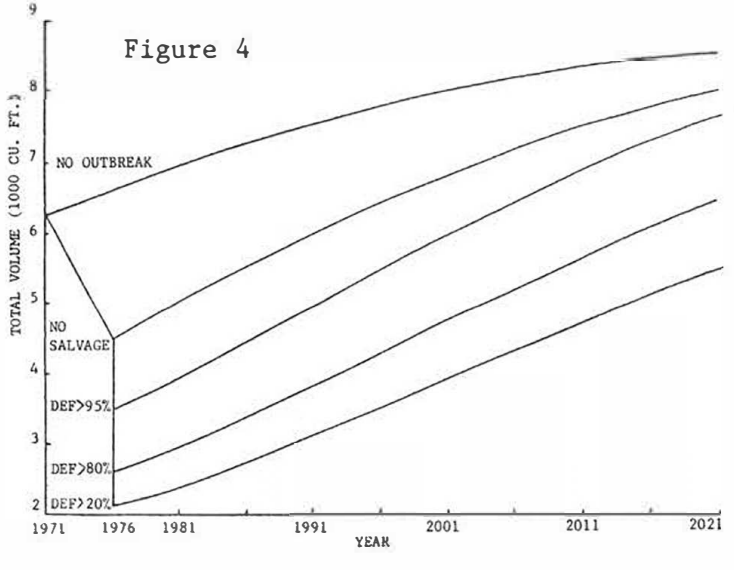


Figure 4
TOTAL VOLUME (1000 CU. FT.)
NO OUTBREAK
NO SALVAGE
DEF>95%
DEF>80%
DEF>20%
1971
1976
1981
1991
2001
2011
2021
YEAR

assumption. Not shown in figure 3 is the application of NPV applied in Phase II; this treatment almost completely controls the outbreak and is therefore coincident with the "no-outbreak" curve. Even virus application in Phase III (NPV3) results in a considerable reduction in volume loss.

Chemical controls are also compared in figure 3. Treatment early in Phase III or before appears effective, even if efficacy is only 80% (see CC3E80, which is an abbreviation of Chemical Control in Phase 3 with an Efficacy of 80%). However, if control is delayed until late in Phase III, it has little effect, even if efficacy is 95% (see CC3L95).

The effect of various salvage intensities is shown in figure 4. Note that the "no salvage" outbreak curve is the same as the "no control" curve in figure 3. If the salvage removes only (surviving) trees with greater than 95% defoliation, the resulting growth rate is somewhat higher than if no salvage had been made. However, when salvage intensity is increased to include trees with lower defoliation levels, residual stand development is retarded. It is apparent that the time required for a stand to reach pre-outbreak volume levels can be lengthened considerably by increasing the salvage intensity.

These figures illustrate the sensitivity of the combined stand prognosis/ DFTM outbreak model to various initial conditions. An understanding of this sensitivity should increase its utility as both a research and stand management tool.

Donald G. Burnell: Predicting Timber Losses by use of a Mountain Pine Beetle Simulation System

As noted by Stage (these proceedings) the stand prognosis model has been developed to the point where stand growth estimations can be made which are useful to the forest manager. We have developed a companion mountain pine beetle (MPB) simulation model which is coupled to the stand-prognosis model (Crookston and others 1978). This combined model will predict beetle induced timber losses in predominantly lodgepole pine (LPP) stands during an epidemic. The MPB/stand prognosis model is comprised of the following components:

1. The stand-prognosis model.

2. A data compression procedure which reduces the data to the dimensionality needed by the MPB component.

3. A resistance evaluation component which uses crown competition factor, proportion of basal area in LPP, and periodic growth ratio to determine stand resistance.

4. The MPB simulation model.

5. A simple damage model which reduces the trees per acre represented by the appropriate sample trees.

The resistance value, stand, and tree class data, are utilized by the MPB simulation model to predict (in a rather complex way) the intensity and distribution of tree mortality. The MPB model is an incremental model which incorporates notions of pioneer beetle density and aggregation (Burnell 1977).

The model represents some of the results of the pine bark beetle component of the IPM project and contain many of the ideas distilled from the various project members at the University of Idaho, Washington State University, and the U.S. Forest Service.

Dave VanDeGraaff: The use of Computer Models to Determine the Effect of Spruce Budworm on Boise Cascade Lands

The prognosis model was used to determine the biological effect of the spruce budworm. By simulating the development of various stand types, with and without spruce budworm, we developed yield tables for the spray and no spray options.

> Moderator's Note: The spray option was run under the assumption that normal mortality and growth rates would be attained by spraying. The no-spray option was run under the assumption that periodic outbreaks of spruce budworm would reduce growth to 69% of normal on grand fir and to 82% of normal on Douglas-fir; outbreaks were assumed to occur every 13 years and last 12 years. In addition, the mortality rates appropriate to small grand fir trees were increased to 371% over normal for the period of infestation.

These yield tables were then used as a basis for the economic analysis. First, we used the economic model "multiploy" (Row, unpublished) designed by the Forest Service. This model was used to make a one acre analysis of the spray, and no spray options. Factors such as silviculture costs, spray costs ($7.50/acre), administrative costs, and stumpage values were included. The stumpage value used was $70.00 per thousand board feet harvested. No planting increases were used in the no spray option, which makes the results conservative.

The cost benefit ratios from this analysis are as follows:

Grand fir sawtimber type	$11.42/1.00
Grand fir small sawtimber	10.57/1.00
Low site alpine fir-grand fir	8.57/1.00
Douglas-fir sawtimber	2.18/1.00
Douglas-fir small sawtimber	2.92/1.00
Douglas-fir seedlings and saplings	5.73/1.00

Since 45,000 acres of Boise Cascade land is presently infected, on 24% of our Idaho ownership, their analysis shows considerable benefit to us on a spray project.

However, a one acre analysis of various timber types does not show the total picture. Boise Cascade's ownership is managed to obtain various objectives, such as:

1. Maximum profit (net present value)

2. Even flow harvest

We used Timber Resource Allocation Model (Timber RAM, Navon, 1971) to determine our allowable cut and harvest schedule. Timber RAM is a Forest Service model which can be used to optimize net present value inside the even flow harvest constraints. To do this, yield tables built with prognosis, delivered values, harvesting costs, and silviculture costs are analyzed.

Yield tables were developed from prognosis showing both the spray and no spray options. If no spray option is used, the cut was forced into the infected areas in the first 10-year period. The results from our Timber RAM analysis show an 8% decrease in harvest volume for the first 30 years, and a 24% decrease in harvest volume in years 31 through 100. The reasons for these volume reductions are:

1. A setback in regeneration, sapling, and pole stands.

2. The harvest of small, vigorous timber, before economic maturity, while allowing old growth, slow growing stands which do not contain grand fir.

This volume reduction is serious in an area of decreasing timber availability, but more startling is the effect on profits. Since Boise Cascade Corporation owns considerable land, stumpage from that land is taken as profit. If the spruce budworm is not sprayed, our profit level drops by 50% during the first 10-year period. Their reduction is due to:

1. Harvest of smaller timber which has a lower delivered value and a higher logging cost.

2. Increased planting costs.

3. Lower volume harvest.

After the 10-year period, the problems became even more serious.

Using the stand prognosis model, coupled with existing economic models, we have been able to put a dollar figure on the effects of the spruce budworm infestation. Managers can use these dollar figures to form decisions.

REFERENCES

Burnell, D. G. 1977. A dispersal-aggregation model for mountain pine beetle in lodgepole pine stands. Res. Popul. Ecol. 19:11-18.

Colbert, J. J., W. S. Overton, and C. White. 1979. Documentation of the Douglas-fir tussock moth outbreak population model. Pacific N. W. Forest and Range Exp. Stn., Portland, OR. (Proposed PNW Research Paper; in review)

Crookston, N. L., R. C. Roelke, D. G. Burnell, and A. R. Stage. 1978. Evaluation of management alternatives for lodgepole pine stands by using a stand projection model. Pages 114-122 In: Mountain pine beetle-lodgepole pine management symposium proceedings. A. A. Berryman and others (ed.): Univ. of Idaho, For., Wildlife and Range Exp. Stn., Moscow. 224 p.

Monserud, R. A. 1978a. Combining the stand prognosis and Douglas-fir tussock moth outbreak models. In: National Society of American Foresters Meeting Proceedings, October 24, 1978, St. Louis, Missouri. In press.

Monserud, R. A. 1978b. Implementation of prognosis model for forest stand development for combined assessment of silvicultural and DFTM control activities: Final report to DFTM Program. USDA For. Serv., Intermt. For. and Range Exp. Stn., Moscow, Idaho, 90 p.

Navon, D. I. 1971. Timber RAM...a long-range planning method for commercial timber lands under multiple use management. USDA For. Serv. Res. Pap. PSW-70, 22 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Row, C. Unpublished. A description of "multiploy" is available from Clark Row, Forest Resources Economics Research Staff, USDA Forest Service, P.O. Box 2417, Washington, D. C. 20013.

Stage, Albert R. 1973. Prognosis model for stand development. USDA For. Serv. Res. Pap. INT-137, 32 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Stage, Albert R., and J. R. Alley. 1972. An inventory design using stand examinations for planning and programming timber management. USDA For. Serv. Res. Pap. INT-126, 17 p.

WORKSHOP: INFORMATION TRANSFER TO THE FOREST RESOURCE MANAGER
Moderator: Jack E. Coster

Nineteen persons attended this Workshop. Technology transfer is basically a problem in communications. The goal of technology transfer is to link new research knowledge to new and improved practices in forestry. The process is complicated by basic differences in motivation and interests between researchers and practitioners. They occupy two quite different professional worlds. The researcher is often characterized as being one who approaches problems logically, the practitioner-administrator depends more on experience and intuition; the researcher attempts to find commonalities; the practitioner-administrator considers each case as being unique; the researcher can seem to live forever with the tentative the hypothetical, the practitioner wants to act on his problem soon and with a high degree of confidence; the researcher asks why, the practitioner asks how.

Technology transfer consists of three separate jobs; basic research, development of practical procedures, and dissemination of the procedures and results. It was suggested that trusting all, or even two, of these components to a single person or group may not be the ideal solution to technology transfer.

Bill Ciesla pointed out that the average lag time between development of a new innovation and its adoption has been estimated at 19 years. Implementation lag may not be attributable to a failure in technology transfer but may indicate that some of the research was done before the time was ripe for its need. Nevertheless, an implementation lag does often exist between research and its use. Some reasons for such a lag are:

1. Too much time is required to collect data under the new system,

2. Information was no longer needed because the original justification for the program no longer existed,

3. Research was conducted in another part of the country and would not apply,

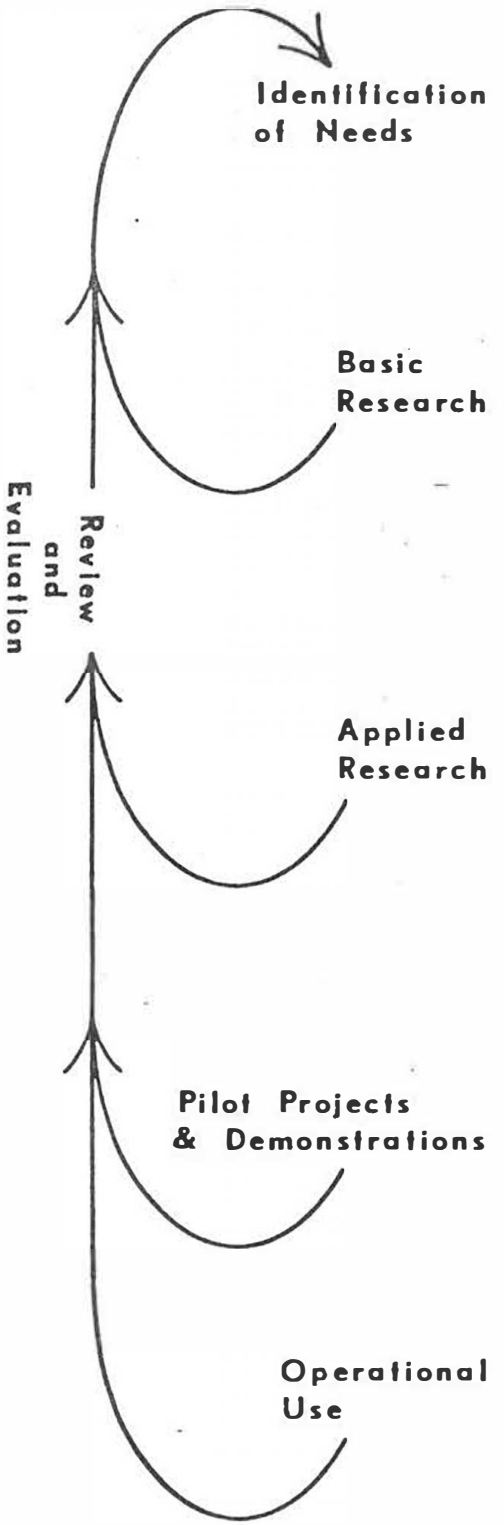
4. The new technology requires collection of more data than necessary for decision-making, and

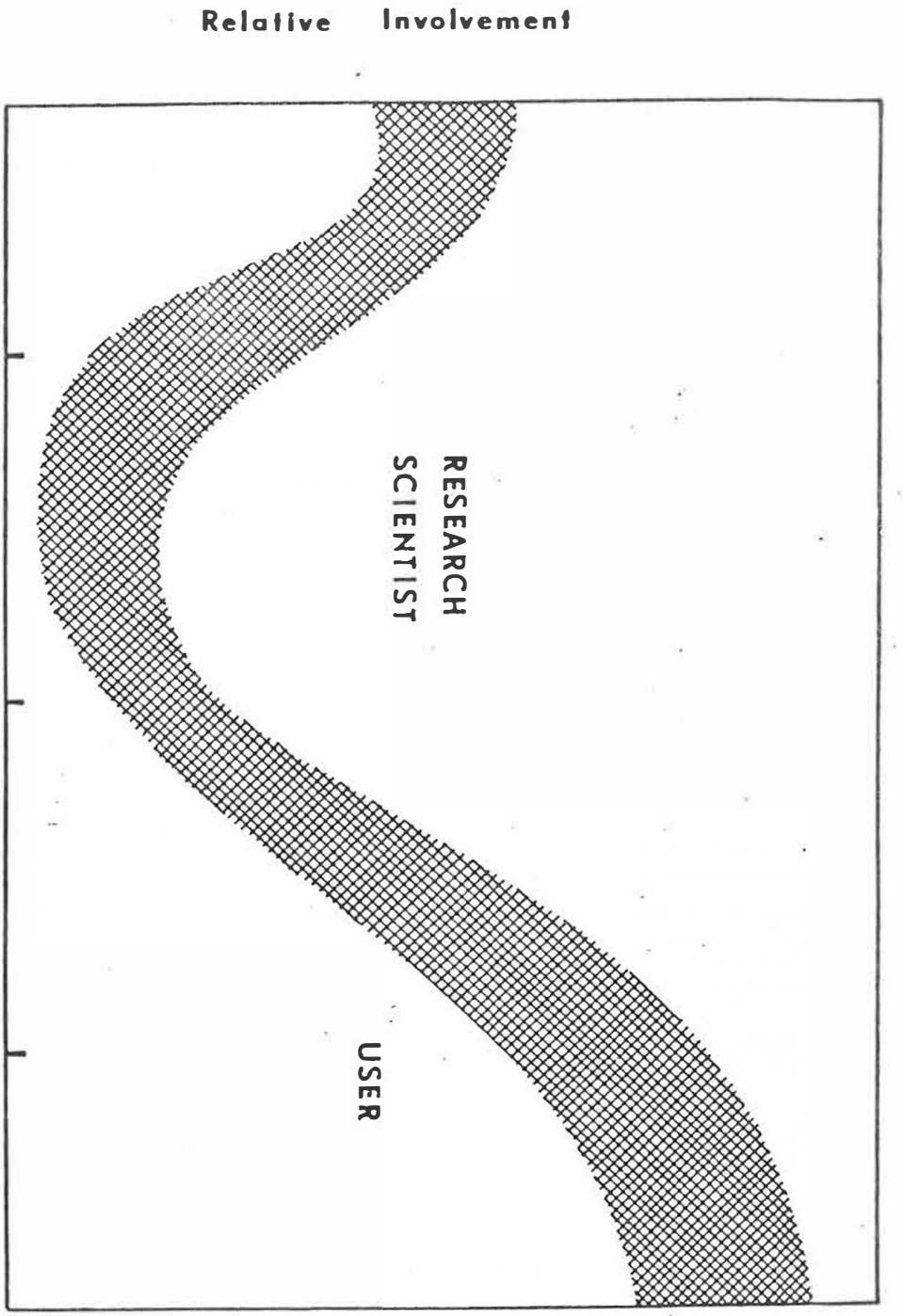
5. There was no source of supply for materials and supplies needed for the new technology.

Bob Thatcher outlined the structure for technology transfer that is being developed within the Expanded Southern Pine Beetle Research and Applications Program. Eight technology transfer teams are being organized to deal with specific areas of technology resulting from research by the Program. Each team is composed of a mix of the researchers who originally developed the technology, and the "linkers" that can serve as go-betweens, and the practitioners. Each team consists of three to eight individuals representing a cross section of these researchers, linkers, and users. The technology transfer teams themselves are charged with the formulation of specific on-the-ground programs to demonstrate and implement new procedures and research methodologies. The overall Southern Pine Beetle Technology Transfer effort is reviewed by a Task Force composed of middle-management persons in forest industry, Federal government, State forestry organizations, and extension services.

Mike Allen surveyed some frustrations that practicing foresters have with research results as they are traditionally passed along to the forester. The research is often in language not readily interpretable by the forester and often requires mathmatical expertise beyond his capability. In addition, much of the research literature that is produced gives no indication as to potential applicability in forest management. Similar difficulties were expressed by Allen in regard to publications in programs intended for the general public. Many of the publications produced by research and extension are too technical and too detailed for easy use by the general public.

A general scheme for relative involvement of researchers and users through the development of new technology was presented by Ciesla and is included as figure 1.


Identification of Needs
Basic Research
Review and Evaluation
Applied Research
Pilot Projects & Demonstrations
Operational Use


Relative Involvement
RESEARCH SCIENTIST
USER

WORKSHOP: STATUS OF RESEARCH ON LOW LEVEL POPULATIONS
Moderator: Dick Schmitz

The objectives of this workshop were to identify those conducting research dealing with low level populations and exchange information regarding research objectives, methodology and results. For purposes of discussion, "low level populations" were considered to be those existing at such low densities that the resulting damage is considered tolerable.

Workshop participants totaled 45 and 22 of those were involved in varying degrees with the study of low level populations. This census revealed current research efforts were equally divided between bark beetles and defoliators. The Douglas-fir tussock moth and spruce budworm are receiving the greatest attention among defoliators and the southern pine and mountain pine beetles among bark beetles. Those involved in research on low level populations, their agency and subject of research are listed at the end of this summary. Many of the research efforts listed are in the planning stage or just underway and consequently little in the way of research results were discussed.

Initial discussions focused on the value of research dealing with low level populations and the problem of convincing administrators they should allot research resources to the study of populations not currently causing intolerable damage. Most felt that results of long term studies and suppression efforts directed at outbreak levels of many of our most damaging forest insects have shown that little can be done to change the course of an outbreak once it reaches this level.

The long term, widespread application of insecticides in the Intermountain West to individual trees infested by the mountain pine beetle was cited as an example. This suppression program was discontinued when analysis of the results showed the beetles eventually killed the same amount of timber whether or not stands were treated. While it took 7 years longer to reach comparable damage levels in the treated stands, the control investment could not be amortized over this period, resulting in the decision to terminate the program.

Many felt it was time we devoted more effort to improving our means of detecting low level populations, determining factors that regulate their population dynamics and evaluating the effectiveness of suppression efforts directed at low level populations. Others felt that past studies of outbreak-level populations have led to the development of a number of hypotheses regarding factors that are responsible for triggering outbreaks. Study of low level populations

would provide an opportunity to field test these hypotheses. The participants recognized the need to convince administrators of the value of such research. One means of drawing attention to the problem and establishing research priorities is through discussions and preparation of appropriate resolutions by the pest action councils.

Lack of operational detection systems to locate low level populations currently hampers most research and suppression activities directed at "low level" populations. The intensity of aerial survey necessary to locate single infested trees or small groups of trees using fixed wing aircraft is considered prohibitive. Current outputs from high altitude photography using aircraft or satelites that can scan vast acreages for minimal cost apparently are not suited to the detection of a few infested trees.

At present the most promising means of detection appears to be the use of pheromones. The success in detecting the Douglas-fir tussock moth was cited as an example of how pheromones might be used to detect other insects when synthetic lures become available. Field tests are underway to determine the effectiveness of synthetic pheromones for censusing the spruce budworm. Similar efforts are underway or planned for a number of bark beetles for which attractants are available. At present one of the major problems is relating the numbers of insects caught at the baited traps to the density or size of the field population and to the damage caused by these populations.

A number of participants stressed the need to relate catches to tree and stand conditions regardless of the means of censusing. Those involved with southern pine beetle research feel that the number of infested trees per group and the distance between groups as determined from aerial survey provide estimate of population density suitable for comparative purposes. Others felt that the density and vertical distribution of bark beetles in a tree in comparison to other associated scolytids provide a relative index to the population density of the target insect.

The importance of changes in population quality as a mechanism that triggers outbreaks was being discussed in the closing minutes of the workshop. The majority felt there was ample evidence to suggest that changes in population quality was a significant factor in triggering outbreaks and that this factor should be studied more intensively as one means of predicting when low level populations had reached a state when they were likely to reach outbreak proportions.

DIRECTORY OF INDIVIDUALS CONDUCTING RESEARCH
ON "LOW LEVEL" POPULATIONS

Name and agency[1/]	Specialty
Barr, William F. (Univ.Idaho)	Indirectly, biological control of weeds
Berryman, Alan A. (Wash.St.U.)	Generalities dealing w/low level
Chatelain, Mark P. (Univ.Idaho)	Mountain pine beetle and associates
Coulson, Robert N. (Texas A&M)	Southern pine beetle
Dahlsten, Don (Univ.Calif,Berk.)	Douglas-fir tussock moth
Gillespie, David (Simon Fraser U)	Deciduous tortricids
Hain, Fred (N.C.St.Univ.)	Southern pine beetle
Hajek, Ann (Univ.Calif)	Natural enemies of Scolytus myltistriatus
Hall, Peter M. (Univ.B.C.)	Douglas-fir beetle, detection, survey
Holsten, Ed (USFS, Anchorage, AK)	Epinotia solondriana-paper birch Choristoneura spp.-white birch
Moser, John (USFS Alexandria, LA)	Southern pine beetle, trapping low level populations
Pitman, Gary (Oregon St.Univ.)	Spruce budworm - west side Douglas-fir
Rasmussen, Lynn (USFS, Ogden, UT)	Mountain pine beetle
Rudinsky, Julius A. (Oreg.St.U.)	Douglas-fir beetle
Schenk, John A. (Univ.Idaho)	Fir engraver, mountain pine beetle, cone-seed insects
Sheehan, Kathy (Univ.Cal.Berkle.)	Neodiprion abietis
Stoszek, Karel J. (Univ.Idaho)	DFTM, WSBW, pineshoot borer in relation to stand dynamics
Tiernan, Charles (USFS, Missoula)	W.spruce budworm on Douglas-fir cone and seed production
Tilden, Paul (USFS, Oakhurst, CA)	D. brevicomis
Voegtlin, David (Univ.Oregon)	Old growth Douglas-fir canopy
Volney, W. Jan A. (Univ.Cal.Berk.)	Choristoneura sp.
Whitney, Stu (PFRC, Victoria)	Mountain pine beetle

[1/] See directory (Appendix) for complete address.

WORKSHOP: UPDATE ON APPLICATION STRATEGIES FOR SPRUCE BUDWORM CONTROL

Moderator: A.P. Randall. F.P.M.I. Envir. Can. Sault Ste. Marie, Ont.
Panel: M. Finnis. B. C. Forest Service, Victoria, B. C.

To assist in the presentation of this topic, a definition of key terms that may be used is in order. According to Webster's International Dictionary (2nd ed.), strategy, tactics and technology are defined as follows:

strategy: the science and art of military command exercised to meet the enemy in combat under advantageous conditions.

tactics: the art or science of disposing or maneuvering troops or ships in the presence of the enemy, or, any system or method of procedure for accomplishing an end.

technology: the science of industrial arts and manufactures.

There may be some confusion between strategy and tactics, therefore, with reference to forest pest management, I would like to suggest that strategy is the basic objective such as saving a valuable stand of timber in a watershed area, or keeping a forest alive, or the eradication of a pest insect or the suppression of a pest as a long or short term objective. Tactics on the other hand includes all the alternatives and means available to select the most efficient means, system or methods employed to achieve the objective, and technology as the equipment or science created or available for use at that particular time.

With reference to the eastern spruce budworm Choristoneura fumiferana (Clem) the tactics for aerial application in the early 1950's in the Province of New Brunswick was developed from the findings that a high tree mortality (B. fir and white spruce) could occur following four years of severe defoliation of current year's foliage. The strategy of tree protection through suppression of larval population by chemicals (1b/DDT/ac), was developed to provide a period of tree recovery and growth, thus preventing further tree mortality. The tactics of high volume application (1 gal. US/ac of 12.5% DDT oil formulation) was aimed at the exposed late 4th, 5th and early 6th instar larvae on flared shoots of new growth. The early strategy and tactics resulted in the preservation of large areas of valuable forests in New Brunswick and Quebec, but the expected achievement of population suppression to the endemic level was hampered by the lack of technological improvements in navigational and application techniques. When the budworm population collapsed it was accepted as a biological bonus.

By the late 1960's a choice of options in technology included the rotary atomizers to produce a fine droplet spectrum for the use of

ultra-low-volume (ULV) concentrate spraying techniques on small (Stearman, Ag-Cats, etc.) and medium-sized (Grumman Avengers TBM, and Snows) aircraft. In the chemical arsenal, low hazard systemic insecticides became available to minimize spray impact on non-target organisms (fish, birds and aquatic fauna). A review of chemical and biological options against the various developmental stages of the spruce budworm (adults, 2nd, early 3rds, late 4th, 5th and 6th instars) were presented. Choice of registered insecticides include Dimecron (adult moths), Fenitrothion, Aminocarb and Orthene (2nd and early 3rd instar) and all four compounds against the late 4th, 5th and 6th instar stages. Promising new materials such as the synthetic pyrethroids are currently under study. Of the registered biological agents, Bacillus thuringensis is used operationally on watershed and other biologically sensitive areas.

Studies are currently being undertaken on a wide range of biological agents such as sex pheromones, insect growth regulators, insect viruses and other pathogens. Of the above group, the sex pheromones and insect viruses (NPV) have reached the experimental field status and show promise as potential future candidates.

A new tactical approach to combat extremely high populations of spruce budworm (2800 egg mass/10 sq. meters of foliage) was introduced in the Province of Quebec in 1972 with the advent of the incremental application technology using multi-engine aircraft, under electronic guidance control for cross-wind parallel swath emission. The resultant uniformity of ULV spray deposition produced using high volume emission rates (100-200 gpm) and spray coverage of 2 square miles/minute opened the possibility of spraying the mobile 2nd and early 3rd instar larvae prior to bud invasion, thus protecting early bud growth and shoot development.

A review of Western Insect control strategy and tactics were presented by Mr.Mike Finnis of the British Columbia Forest Service using examples of recent programs against the Western Spruce budworm (*C. occidentalis*), the Blackheaded Budworm, (Acleris gloverana), and the Douglas fir Tussock Moth, (Orgyia pseudotsugata). While the basic strategy to protect the forest remained the same; i.e., (reduction of epidemic levels of larvae to near endemic condition), the tactics and technology were strikingly different because of differences in topography, tree growth, and meteorological conditions. Because of the steepness of the terrain, the greater surface area of tree canopy, and air mass movement in mountainous terrain, the use of ULV application techniques and high speed large aircraft are not recommended for use in B.C. This was aptly demonstrated in 1973 when a Douglas Invader A-26 spray aircraft was used to spray the northern forest area of Vancouver Island to control the Blackheaded Budworm. Unfortunately, because of the steepness of the terrain, and high flying speed of the A-26 aircraft, the swath path was much higher than that which would have normally occurred over flat rolling forest lands, thus reducing spray coverage and hence control effectiveness of the fenitrothion spray against the larvae.

In 1975 the aerial application tactics were modified to use small aircraft (Ag. trucks) capable of low level contour flying to dispense water

formulation of B. thuringiensis into the tree canopy. Spray deposit results were excellent, but unfortunately only marginal control was achieved with the BT formulation.

In 1976, the area was resprayed using a water based insecticide formulation (1 lb. Orthene 1 gal/ac.) using the same aircraft and application techniques. Spray timing was advanced to coincide with larval hatch, because of the severity of previous years' defoliation. The results were extremely encouraging with very low levels of defoliation. The tactics included "on the spot" decision making for maximum effectiveness.

In 1977 an aerial spray program was initiated to spray 100,000 acres of Douglas Fir forest infested with the Western spruce budworm. Sevin-4 oil and Orthene were selected with Helicopters being recommended as the spray vehicle. Unfortunately, a shortage of spray equipped machines and spray pilots existed. After considerable expense and time to equip the Bell 205's, the program was cancelled by the Provincial Cabinet on a political decision.

In 1978, a co-operative research program was initiated with the Can. For. Ser. and the B.C. For. Serv. to evaluate a new biological agent (nuclear polyhedrosis virus) and Bacillus thuringiensis against the western spruce budworm, using a Cessna Ag. wagon spray aircraft calibrated for high volume emission. The data is currently being analyzed.

Conclusions

The most significant findings from this work session may be summarized as follows.

1. Strategies and tactics developed for the eastern spruce budworm may not necessarily be applicable to the Western forest regions.

2. To ensure a high degree of success, strategies, tactics and application techniques should be developed for each pest according to geographical location, topography and forest type.

3. Biological, phenological, meteorological and sociological conditions could play a prominent part in the choice of options open to the forest manager.

4. A noticeable gap in technology transfer appears to exist between research and operations.

WORKSHOP: GRADUATE STUDENT ACTIVITIES IN FOREST ENTOMOLOGY
Moderator: Bob Loveless
Participants: Sean Swezey, Beth Willhite, Steve Laursen, Bob McKnight, Steffan Lindgrin

Graduate Students from several universities throughout the western United States and Canada participated in a workshop designed to facilitate communications between fellow students of forest entomology. The workshop was informal with each presentation followed by a good discussion. Each participant described the forest entomology program and courses at their respective schools.

I would like to personally thank the participants, especially Steffan Lindgrin who consented to a presentation at the last minute. Mr. Lindgren talked about his work at Simon Fraser University with ambrosia beetles in dry land log storage areas. Since Mr. Lindgrin is from Sweden, we prevailed upon him to describe forest insect problems in Sweden, which at the moment, involve a pine weevil in seedlings and Ips spp. in spruce slash. Several other students from the University of Idaho and the University of California at Davis described briefly their projects. Many attending thought this workshop should become an annual event in the WFIWC.

Effects of Insecticides on the Survival of Selected Natural Enemies of the Western Pine Beetle (Dendroctonus brevicomis Le Conte)

Summary

Sean L. Swezey
Division of Biological Control
University of California, Berkeley

Since the early 1930's, direct application of penetrating oils and synthetic organic insecticides for remedial or preventive bark beetle control has been described and carried out as a control measure for the western pine beetle, Dendroctonus brevicomis Le Conte. While much research attention has been directed toward evaluation of toxicity and control potential of various insecticides for the western pine beetle, a limited data base exists for the assessment of the effects of these compounds on arthropod natural enemies and associates of the western pine beetle which are secondarily attracted to infested trees. The potentially disruptive nature of insecticides to naturally-occuring biological control of the western pine beetle is poorly understood.

A field experiment was devised to measure the influence of the bark beetle insecticide gamma benzene hexachloride (lindane) on the survival of selected natural enemies. Effects of protective lindane treatments were evaluated in the summer of 1978 in Shasta-Trinity National Forest (California) by comparing numbers of insects captured on deadfall traps and arrival screens placed on groups of sprayed ponderosa pines and unsprayed control trees. Both treated and untreated sample trees were baited with a mixture of western pine beetle attractants to induce arrival and attack by D. brevicomis and subsequent arrival of natural enemies.

Preliminary analysis of the results of this experiment indicate that rate of fall (and presumably mortality) of the coleopterous predators Temnochila chlorodia, Enoclerus lecontei, and Aullonium longum is significantly greater from sprayed trees and from unsprayed controls. Further analysis of trapped insect data will be required to confirm this finding.

Hymenopterous parasitoid mortality is not adequately sampled by this method. An emergence study is planned for the 1979 field season to assess impacts on this group of natural enemies.

Chirality of Mountain Pine Beetle Attractants

Summary

Bob McKnight
Department of Forest Science
Oregon State University, Corvallis

The attractiveness of a mountain pine beetle pheromone and host cofactor depends, in part, on absolute configuration. Under field conditions, two mountain pine beetle populations were monitored for response differences to optically pure trans-verbenol and alpha-pinene. Beetles in a western white pine stand exhibited a significant preference for (1S, 4R, 5S) - (-) trans-verbenol (P = .046) and (1R, 5R) - (+) alpha-pinene (P = .026). Beetles in a lodgepole pine stand var. murrayana also preferred (-) trans-verbenol (P = .04) but indicated no preference for alpha-pinene (P - .83).

These results indicate the stereospecificity for trans-verbenol was maintained between the two stands studied. The lack of uniform response to alpha-pinene may have developed during the coevolution of these allopatric populations. Considering these differences in response, the more attractive compounds should be utilized in monitor or control programs.

Genetic Variation in Western Spruce Budworm Populations of Idaho and Montana

Summary

Beth Willhite
College of Forestry, Wildlife and Range Sciences
University of Idaho, Moscow

Knowledge of the genetic variation present in pest populations contributes a great deal to understanding their population dynamics and population movement. This study is based on the hypothesis that unique genetic characters of western spruce budworm populations are associated with outbreak stage, and that these unique characters can be used as a predictive tool through population monitoring techniques. My objectives are to (1) observe the amount of inherent genetic variation present throughout the study area, (2) postulate reasons for the observed variation, and (3) search for "marker" loci with predictive potential.

Samples were collected with the help of Forest Service and State cooperators during summer, 1978. Fifteen sites were selected on the basis of outbreak age and geographical location. Fifty-100 sixth instar larvae were collected from at least 3 different trees at each site. Samples were shipped to the lab in Moscow, Idaho, frozen at -5° C., and analyzed throughout the ensuing summer, fall and winter months.

I examined the genetic structure of the sampled populations by looking at stainable enzymes. Because all enzymes are proteins, and proteins are synthesized from DNA units (genes), enzymes allow one to look almost directly at a representative portion of an individual's genetic makeup. The technique used to analyze the samples was starch gel electrophoresis. Electrophoresis is the separation of charged molecules in an electric field. In this case, the charged molecules were enzymes.

The data require further analysis. Overall genetic similarity between geographically separated populations indicates that gene flow between populations is fairly high, or that major selective forces are similar over the entire study area. However, significant differences exist between populations in three enzyme systems. Reasons for the differences will be examined in future data analysis.

Niche Specialization in the Grand Fir Bark Beetle Community

Summary

Steven Laursen
College of Forestry, Wildlife and Range Sciences
University of Idaho, Moscow

The impact of bark beetle attack on grand fir stands is generally attributed to one dominant species, Scolytus ventralis. However, grand fir serves as host to nearly 20 species of bark and ambrosia beetles throughout its range in the northwestern United States and adjacent British Columbia. A complex of 14 species was found inhabiting grand fir in northern Idaho. Each species occupied a distinct niche during the period of colonization, as defined by tree and microhabitat conditions. The most successful and competitive species occupied the widest diversities of habitat.

Scolytus ventralis and Pityokteines elegans were the most abundant species and appear to bear the greatest potential for causing widespread damage. Dryocoetes confusus, previously reported to be one of the two most destructive species, was not found in the 72 trees sampled. Pseudohylesinus granulatus was found in 65% of the sample trees.

Scolytus subscaber was the only major species that did not attack the full range of tree heights and crown classes sampled. It was restricted to heavily suppressed trees at least 65 years old with very thin phloem (less than 3 mm). This species may be beneficial to man's timber interests, serving as a natural thinning agent in stands with small low-value trees.

P. granulatus attacks were only found in the area from .5 meters below the soil line to 1 meter above. Nevertheless, it attacked the full range of phloem thickness and diameter of bolts examined in this bolt position. This species could serve as an indicator of imminent tree mortality because: (1) it is easily detected at ground level, (2) its attacks usually occur a year in advance of those of other species, (3) no sample tree contained only its attacks and (4) it has been implicated as a vector of root disease and stain fungi.

S. ventralis and P. elegans occupied nearly the entire range of bolt diameters, positions, and phloem and bark thicknesses sampled. Apparently no tree that is predisposed to bark beetle attack is safe in the presence of these two species.

A Stand Hazard Rating for Mountain Pine Beetle in Ponderosa Pine in Western Montana

Summary

Bob Loveless
School of Forestry
University of Montana, Missoula

Logging practices during the early part of this century in western Montana have resulted in vast expanses of second-growth ponderosa pine in the 60-80 year old group. Because of wildfire protection and the lack of adequate precommercial thinning programs for the last 50 years, many of these stands are overstocked and in poor vigor. Mountain pine beetles are heavily infesting the oldest of these second-growth stands with no evidence of subsiding in the near future. Therefore, an attempt to produce a stand hazard index based on easily obtainable stand parameters is the goal of this study.

A multiple regression model will be used to predict amount of beetle-caused mortality a land manager could expect given the current stand conditions of age, site index, stocking level and growth rates. Preliminary results indicate the beetle can sustain an infestation in trees six inches dbh and larger and that stocking level, although important, does not by itself indicate mortality levels. On class II and III sites, sample plots of 110 square feet per acre of basal area initially were thinned to 65-70 square feet per acre by the beetle.

Growth rates of attacked trees are extremely slow--as little as 0.04 inches radial growth for the last five years. Phloem thickness of attacked trees ranges from 0.04 inch in a 4 inch dbh tree to 0.22 inch in a 20 inch dbh tree. Growth rates, total plot basal area, average ponderosa pine dbh, and phloem thickness appear to be the most significant variables in the model.

WORKSHOP: RISK RATING STANDS FOR POTENTIAL PEST BUILDUP
Moderator: Ladd Livingston
Panelists: John M. Wenz, Paul Gravelle, George T. Ferrell, Ken Gibson, Mal Furniss, Robert Heller, John Schmid

As an introduction to the workshop John Wenz told about the development and implementation of Keen's Risk Rating System for the western pine beetle.

During the early 1900's, losses of many mature and overmature ponderosa and Jeffrey pine stands due to attack by the western and Jeffrey pine beetles created serious problems for managing these areas on a sustained yield basis. Direct control methods were inadequate. Attempts were made to determine the underlying causes of bark beetle outbreaks.

One aspect of these investigations, conducted primarily in the ponderosa pine regions of eastern California and Oregon, was an attempt to define the type of tree that represented the greatest risk of being killed by bark beetles. The risk rating systems that were developed derived to a large extent from the tree vigor classifications designed primarily for silvicultural purposes proposed by Dunning (1928). Essentially two systems were developed; a "tree classification system" devised by Keen (1936, 1943) and the "California risk rating system" proposed by Salmon and Bongberg (1942).

The Keen system established a 16 group classification based on two variables, age and crown vigor, each divided in four subclasses. The Salmon and Bongberg approach established a four category risk system based almost completely on crown characteristics such as needle length and color, needle complement and the degree of twig and branch killing. The Keen system classified trees as to the greatest average susceptability to beetle attack, attempted to determine overall inherent vigor, and was intended to provide long-term protection through selection cuts that removed approximately 40-50% of the stand volume. The Salmon and Bongberg system identified trees showing high, current, immediate risk that were likely to die in the next few years and was an attempt to reduce short-term beetle losses over large areas through selection cuts that removed minimal volumes. Through time, the California risk rating system was modified into a penalty system that assigned trees a numerical penalty for each condition of poor health, the sum of which indicated the degree of risk (Miller and Keen, 1960).

Quantitative data presented by Miller and Keen (1960) and Wickman and Eaton (1962), primarily from Oregon and California, indicate that treated stands suffered reduced bark beetle related mortality in comparison with untreated stands and that mortality reduction is negatively correlated with time after treatment.

Neither the Keen or the Salmon and Bongberg system are silvicultural systems, but rather are techniques that can be used by the forest manager, where applicable, within the context of resource management objectives.

1. Dunning, Duncan. 1928. A Tree Classification for the Selection Forests of the Sierra Nevada. Jour. Agric. Res. 36(9):755-771.
2. Keen, F.P. 1936. Relative Susceptability of Ponderosa Pines to Bark-Beetle Attack. Jour. For. 34:909-927.
3. Keen, F.P. 1943. Ponderosa Pine Tree Classes Redefined. Jour. For. 41:249-253.
4. Miller, J.M. and F.P. Keen. 1960. Biology and Control of the Western Pine Beetle. USDA-Forest Service Misc. Pub. 800. 381 pp.
5. Salmon, K.A. and J.W. Bongberg. 1942. Logging High-Risk Trees to Control Insects in the Pine Stands of Northeastern California. Jour. For. 40:533-539.
6. Wickman, B.E. and C.B. Eaton. 1962. The Effects of Sanitation-Salvage Cutting on Insect-Caused Mortality at Blacks Mountain Experimental Forest 1938-1959. USDA-Forest Service Pacific Southwest Forest and Range Experiment Station Tech. Paper No. 66. 39 pp.

Paul Gravelle explained Potlatch Corporation's efforts to utilize a risk rating system for the fir engraver in grand fir. About half of their growing stock is grand fir. Thus, the company is concerned about the lethal pests of grand fir, especially the fir engraver, *Scolytus ventralis*.

Recently a hazard rating model for risk rating grand fir stands was developed at the University of Idaho (Moore, et al. 1978). The model provides a stand hazard index (SHR), which is a function of Crown Competition Factor and tree species diversity. We have inserted this model as a subroutine in a growth prognosis model (Stage 1973). This works very nicely, because the variables needed to compute SHR are available from the growth model. The SHR values are computed and printed for each growth cycle.

Although we have just added this hazard rating model, we feel that it will enhance the stand management decision process, especially

for precommercial and commercial thinning decisions in naturally regenerated stands. We have an economics package, coupled to the growth model, which provides economic analysis of proposed thinning investments. The SHR values will give us better insights into the potential fir engraver hazards of thinned and unthinned stands throughout the rotation. The SHR values may influence decisions to alter species composition, stem spacing, or rotation age.

1. Moore, James A., J.A. Schenk and C.R. Hatch. 1978. Validation and Refinement of a Hazard Rating Model for Fir Engraver Caused Mortality in Grand Fir Stands. Forest Sci. 24:309-312.
2. Stage, A.K. 1973. Prognosis Model for Stand Development. USFS Resource Paper INT-137. 32 pp.

George Ferrell explained a project to develop an individual tree risk rating system. Preliminary risk-rating systems, predicting the probability of a tree's dying within 5 years based on crown and bole characteristics, were developed for mature red fir and white fir in northern California. For field use, the systems were formulated as Award-Penalty Point Systems, in which the tree is awarded points based on ratings of some characteristics, and penalized points based on ratings of others. The difference between the Award, and Penalty Point Totals, termed the Risk Point Total, is related to the percentage of a hypothetical population of identical trees which are expected to die within 5 years.

The systems are applicable to firs at least 10 in. (25.4 cm) in dbh, growing in mature stands, with the original overstory at least partially intact, in northern California. Outside this range in central and southern California, the systems may be used only tentatively pending the results of studies underway to test, and verify or modify, the systems in these areas.

The risk-rating systems were developed by characterizing living, and recently dead, firs during initial surveys of 47, 20-acre (8.1 ha) plots in northern California during the years 1975-7. Totals of 1012 red first (851 live, 161 dead), and 2571 white firs (2430 live, 141 dead) over 10 in (25.4 cm) in dbh were examined in virgin and cutover stands. Tree characteristics were subjected to computerized screening to select variables capable of predicting tree death. For red fir, the risk predictors selected were: crown class, percent live crown, top condition, and percent crown raggedness. For white fir they were percentage of crown with branches oriented horizontally or upswept, crown density, percent crown raggedness, and whether living inner bark (phellum) was visible in bark crevices at breast height.

Ken Gibson explained that the current mountain pine beetle infestation, which began in the late 50's, has now reached epidemic proportions over hundreds of thousands of acres of lodgepole and ponderosa pine in six western states. The majority of the existing infestation is concentrated in even-aged lodgepole pine stands in Montana, Idaho, Utah, and Wyoming, and stretches north into British Columbia.

Within the recent past, researchers have identified a set of stand characteristics which identify those stands of lodgepole pine that may be susceptible to a mountain pine beetle infestation. Using these characteristics, a risk-rating system has been established by which a given stand can be placed in a hazard category--high, moderate, or low. Further, it is now possible to predict which stands are most likely to be infested and what approximate losses might be. The stand criteria evaluated are: elevation-latitude, average age, and average d.b.h. Risk factors are assigned according to the following schedule:

Elevation-latitude	Average age	Average d.b.h.
High (1)	≤60 (1)	<7" (1)
Moderate (2)	60-80 (2)	7-8" (2)
Low (3)	> 80 (3)	> 8" (3)

By multiplying the stand risk factors together, a hazard category is obtained: Low, 1-9; moderate, 12-18; high, 27.

Using this information, we are able to inform the resource manager as to the susceptibility of those stands for which we have inventory data. These procedures, along with management techniques which have been developed, can greatly facilitate the land manager in his planning efforts.

Ken also showed an example of the COMARC system of computerized mapping that FIDM in Region 1 is looking at for use in insect and disease work. One complete ranger district had been mapped as to its potential hazard from MPB in lodgepole pine.

Mal Furniss explained work being done with the Douglas-fir beetle in stands of Douglas-fir.

Variations in individual trees, stands, climate, weather, and "disturbances" are major factors that control the presence and abundance of the beetle. An understanding of Douglas-fir beetle population dynamics is useful in developing a stand susceptibility classification.

To explain the dynamics of the beetle-host tree system we have developed the following verbal model.

> "Disturbances such as windstorms and fire contribute to increased Douglas-fir beetle populations. When such disturbances cease, beetles seek out and attack live trees; their success depends upon the susceptibility of the attacked trees. Trees damaged by snow-breakage, possibly those defoliated by tussock moths, stressed by drought, or infected with root rots are susceptible and contribute to furtherance of the outbreak.
>
> The proportion of Douglas-fir in a stand, and its density and age are positively correlated with susceptibility. Any of these factors can limit damage, but high density can result in somewhat younger trees being attacked.
>
> As the susceptible trees are killed by beetles or removed by logging or, as the environmental conditions improve (favoring growth and water relations), resistance to population expansion mounts. Size of infested groups declines and a higher proportion of attacked trees survive. Numbers of natural enemies appear to be independent of prey density; influence of enemies increases after the bark beetle population subsides. Populations are maintained at an endemic level primarily by tree resistance and natural enemies."

If you accept that account of the goings-on, it follows that the genesis of outbreaks may be interrupted by: (1) sanitation measures and (2) by lowering density, age and purity of Douglas-fir, each of which appears to limit beetle numbers. It probably doesn't require an intricate stand classification to accomplish these actions, and any silvicultural treatment should reduce Douglas-fir beetle damage. However, forest managers may want a means of directing cuttings where risk is greatest at any one time and locality. The procedures being developed are intended to define more clearly where the risks lie.

For the methods of analysis we are greatly indebted to Dr. David Hamilton, INT Moscow. The SCREEN program (Hamilton and Wendt 1975) is a versatile and efficient way of relating many independent variables (e.g. stand characteristics) to a dichotomous dependent variable such as living or beetle killed Douglas-fir. Output of the SCREEN program is used to model probability or mortality (Hamilton and Edwards 1976), making use of a non-linear regression program, RISK (Hamilton 1974).

1. Furniss, M.M., M.D. McGregor, M.W. Foiles and A.D. Partridge. Chronology and characteristics of a Douglas-fir beetle outbreak in northern Idaho. USDA For. Serv. Gen. Tech. Rep. Accepted for publication.
2. Hamilton, David A., Jr. 1974. Event probabilities estimated by regression. USDA For. Serv. Res. Pap. INT-152, 18 pp. Intermountain Forest and Range Exp. Stn., Ogden, UT 84401.
3. Hamilton, David A., Jr., and Bruce M. Edwards. 1976. Modeling the probability of individual tree mortality. USDA For. Serv. Res. Pap. INT-185, 22 pp. Intermountain For. and Range Exp. Stn., Ogden, UT 84401.
4. Hamilton, David A., Jr., and Donna L.R. Wendt. 1975. SCREEN: A computer program to identify predictors of dichotomous dependent variables. USDA For. Serv. Gen. Tech. Rep. INT-22, 20 pp. Intermountain For. and Range Exp. Stn., Ogden, UT 84401.

Robert Heller explained his work on the Douglas-fir tussock moth as follows.

A predictive mathematical model (probability regression equation) was developed which identifies the variables which can be measured on resource aerial photographs that relate to forest stands having a high likelihood of Douglas-fir tussock moth (DFTM) defoliation.

The stand variables which the forest manager measures on his own resource photographs and topographic maps are:

1. slope in percent (nearest 10%)
2. aspect in degrees (nearest 22.5^{o})
3. stand density (nearest 10%)
4. elevation (nearest 40 ft)
5. crown diameter (nearest 5 ft)
6. topographic position (ridge, side slope, bottom)

The values for these variables are entered into the following RISK equation:

$$\underline{P} = \left\{1 + \exp\left(-\left(-.431977 + -.00011853 \text{ elevation} + .00283957 \text{ slope} + .453617 \text{ cos. of aspect times tan. of slope} + .779423 \text{ sine of aspect times tan. of slope} - .235660 \text{ topographic position} + .0217976 \text{ stand density} + .0232085 \text{ crown diameter}\right)\right)\right\}^{-1}$$

The "P" value defines the probability of that stand being defoliated in percent during the next DFTM outbreak. Thus, a stand having a probability value of 25% of being defoliated is a much lower risk than one with a value of 80.

The manager can determine the probabilities of his own stands being defoliated and then make silvicultural decisions on how to best reduce the risk. For example, he may decide to remove all old overstory fir trees growing on southeasterly facing slopes and which had a high probability value of defoliation.

A "how to do it" manual was prepared for the DFTM program which describes how the manager can classify stands within a watershed. This manual has not yet been published; however, the Forest Insect and Disease Management group from the Rocky Mountain Region has proposed that stands within one ranger district of the Clearwater National Forest be risk rated for probability of DFTM defoliation. It is expected that photo interpretation will be underway by April 15, 1979 on this pilot test.

John Schmid explained that a stand rating for spruce beetles he is working on is based on 4 stand characteristics--physiographic location, d.b.h., basal area, and percent of spruce in the canopy. Each characteristic has 3 levels of risk (low, medium, high) and each of these levels is assigned a number from 1-3 (low-high) depending on the stand value for that characteristic. The assigned numbers are summed and their total is compared to 3 levels of stand susceptibility (again low, medium, high). Whichever level it fits into is the rating of the stand.

The rating system has received limited use in the Rocky Mountains. In New Mexico, the FIDM staff of Region 3 has encouraged its use in managing the spruce-fir stands of northern New Mexico. In Montana, McGregor, of the FIDM staff in Missoula, has used it in advising district personnel in the management of their spruce stands.

Recently, J.A. Logan, Colo. State Univ., has written a computer program which will calculate the stand rating from the original inventory record of a stand obtained during the stage II inventory. The program does all the mathematics - the operator has only to punch in the site information. Eventually we foresee the program being incorporated as a subroutine into the stand program of each region wherein it will provide the stand rating as an adjunct statement in the stand printout.

Garland Mason of the School of Forestry, Stephen F. Austin State University, Nacogdoches, Texas, was present at the workshop. He has been involved in developing a hazard model for silvicultural management of the southern pine beetle. Because his work involves a different perspective in gathering base information I am including a summary of his work.

During the period 1973-1976 data were collected to relate Southern pine beetle (SPB) infestation occurrence to associated site and stand conditions. Over 1100 infested and baseline plots have been established under guidelines recommended by an ESPBRAP coordinated project. The relationship between stand conditions and SPB hazard have been statistically encouraging; but there is need for on-the-ground verification of predictive models. Field testing through the use of aerial photographs has been initiated. Stand mapping has been completed on ten 18,000-acre test blocks, to a 25 acre stand minimum, using existing 1/60,000 NASA color infrared photographs. Stand characteristics of pine stocking, BA/A, crown closure, DBH and height were extrapolated from large scale 35 mm sample strips at scales of 1/10,000 and 1/5,000. Landform was derived from USGS topo quads. Field checks revealed an average accuracy of 92% in stand information extrapolated from large scale sample strips to non-sampled areas. A total of 771 stands representing 81 condition types were distinguished within the 180,000 acre test area.

Preliminary discriminant analyses of ground data using photo recognizable variables produced a discriminating efficiency of 78%. While these analyses are continually being upgraded, verification has been initiated by applying predicted results to stand map conditions. Predicted stand hazard is being compared to Texas Forest Service historical occurrence data to evaluate field applicability of the model.

An "air model" is being simultaneously prepared by relating spot occurrence to stand conditions as they appear on the photo-produced stand maps. Development of such a model would provide a means for extension of the above rating system outside those areas in which ground plot data were collected.

In the course of preparing for this workshop I have encountered other investigators working on some aspect of risk rating. These are listed below in case someone might be interested.

1. George S. Puritch, Research Scientist
   Canadian Forestry Service
   Pacific Forest Research Centre
   506 W. Burnside Road
   Victoria, B.C. V8Z 1M5
   Canada

   George and a group of scientists are looking at the heeling responses in trees, how these are affected by stress such as drought, and how they are affected by pest insects or pathogens.

2. John Schenk
   College of Forestry
   University of Idaho
   Moscow, Idaho 83843

   Mountain Pine Beetle; Fir Engraver

PANEL: FOREST ECOSYSTEM APPROACH TO TREE-PEST INTERACTIONS
Moderator: Gary Pitman
Panelists: Dale Norris, Dick Waring, Karel Stoszek, Jerry Franklin, John Wenz, David Perry, Don Dahlsten, John Goeschl, Stan Barras, David Rhoades

Considerable information has been accumulated over the last 5-10 years on how forest ecosystems function and how the interacting components affect host and pest population dynamics. Panel members, all specialists on one or more components of forest ecosystems, were asked to comment on the "state of the art" of their respective studies and attempt to relate it to some aspect of host-pest interactions. An effort was made to pair the speakers (except the first and last) so their subjects would be complementary--that is, to emphasize the host and/or pest according to habitat types, phloem physiology, stand conditions, nutrition, associates, or other aspects of the system.

All but one panelist submitted abstracts for this proceedings. Abstracts were edited for clarity.

Dale Norris, Departments of Entomology, Forestry, and Neuroscience, University of Wisconsin, Madison, WI 53706

SYMBIOSIS BETWEEN FOREST INSECTS AND ENTOMOLOGISTS

The decision is in--we surely have overreacted to the presence of insects in forests. For almost a century, North American reseach on forest insects has focused primarily on their short-term impact in the forest. Clearly, we should now direct our attention toward understanding their long-term interactions with fundamental forest ecosystem processes (e.g., primary production and nutrient cycling). We need such information to even hope to develop sound strategies for our interactions with forest insects. Yes, we must settle for symbiotic interactions with insects in forest ecosystems because they have as much "ecological business" there as we do.

Richard H. Waring, Department of Forest Science, Oregon State University, Corvallis, OR 97331

SEEKING SYMPTOMS AND PRESCRIBING CURES

Science continues to uncover new details illustrating the complexity of life. Yet from studies of natural ecosystems, simplicity emerges at many levels. Hundreds of species are found to represent members of only a few functional groups. Moreover,

an ecosystem may function quite adequately with only a single representative of some functional groups. Major processes controlling water movement, carbon assimilation, and decomposition are universal; only the rates at which these processes operate vary from one ecosytem to another and often, predictably.

In all ecosystems, form reflects function. Moreover, within each structural unit, small changes in carbon, mineral, or water content mirror changes in the rates of key processes. Thus, if we wish to judge how efficiently a forest mobilizes water and minerals to assimilate carbon, we must look at the trees making up the forest.

A core of wood extracted from the stem shows how well roots operate and how efficiently leaves convert sunlight and carbon dioxide to biomass because such a core indicates the rate at which wood has been laid down, not only in the stem but throughout the entire tree. The thickness of sapwood in a core, when converted to cross-sectional stem area, provides an indirect linear estimate of a tree's leaf area. The ratio between basal area growth and sapwood basal area is a sensitive measure of growth efficiency, reflecting biomass increment per unit of leaf area. In fast-growing trees, the ratio is high; in more slowly growing ones the ratio decreases, sometimes to a critical level below which trees die or become susceptible to disease or insects.

Monitoring the relative water content of sapwood, we have discovered that cold or droughty soils restrict the rate at which roots absorb water, resulting in reduced stem-water content. Diseased roots also affect water uptake. Trees with low relative water contents eventually must reduce their photosynthesis and growth.

Nutritional stress is reflected in the balance of critical minerals held in older foliage at the time of leaf fall. When minerals are limited, they are extracted and stored elsewhere before leaf abscission; when abundant, they remain to provide a rich litter.

Quite possibly, the health of a forest and its susceptibility to many insects can be accurately diagnosed through such relatively simple but sensitive structural indices of function. Such mirrors reflect the ecosystem condition and can help us detect forests requiring treatment.

Karel Stoszek, College of Forestry Resources, University of Idaho, Moscow, ID 83843

ECOSYSTEM CONSIDERATIONS IN FOREST MANAGEMENT

Abstract not submitted.

David A. Perry and Gary B. Pitman, Department of Forest Science, Oregon State University, Corvallis, OR 97331

GENETIC AND ENVIRONMENTAL FACTORS IN PLANT RESISTANCE TO PESTS

Interaction between plants and insect pests takes many forms, but all are mediated by the genetic structure of both host and pest populations and the environmental matrix within which interaction takes place. These factors may be profoundly influenced by modern silvicultural practices.

Much genetic resistance to pests is due to diversity within the plant community rather than to single or multiple factors of resistance residing in individual plants. Co-evolutionary arguments suggest that biochemical resistance based on one or a few chemical species (e.g., a single alkaloid within a plant community) may be quickly overcome by pest populations. However, biochemical diversity within a plant community forces pests to specialize, thereby removing the large, concentrated food base which is probably a prerequisite for pests to become epidemic. Many laboratory and field experiments support this theoretical argument.

We suggest that phenologic diversity within the plant community is also an important pest-resistance mechanism. Environment is likely to place important limits on the degree of phenologic diversity which a plant community can tolerate. Therefore, the relative importances of biochemical and phenologic diversities probably vary across environmental gradients yet to be defined.

To the extent that diversity is important in pest resistance, deliberately selecting for genetic uniformity (not necessarily equivalent to species monocultures) seems ill-advised. Other silvicultural practices may also affect host-pest relations. Plant biochemistry is modulated by environment, and evidence suggests that this is true for plant phenology as well. To the pest population, changes in plant phenotype induced by practices such as fertilization or thinning are equivalent to genetic changes in the host population. Although these alterations are almost certain to affect host-pest relations (as has been shown for fertilization), the nature of this effect in any given situation

cannot now be predicted. It will depend on the initial state of the system, i.e., the relative importances of different resistance strategies and the directions in which these are shifted. We need deeper knowledge of the ecology and genetics of forest communities to understand the consequences of our actions and to avoid moving the system into undesirable dynamic modes.

Jerry F. Franklin, Forestry Sciences Laboratory, USDA Forest Service, Corvallis, OR 97331

INSECT PROBLEMS FROM AN ECOSYSTEM PERSPECTIVE

Most insect pest problems can only be properly addressed in an ecosystem context because environmental and stand conditions not only directly influence pests but also determine host susceptibility. Some insects (e.g., Sitka spruce weevil) are primarily constrained by climate. Environment influences other pests (e.g., balsam woolly aphid) directly by determining population levels and indirectly by affecting tree growth rates (depth and density of bark). Stand conditions can create susceptible individuals (e.g., mountain pine beetle in overstocked young ponderosa pine stands). Any pest research and/or management program must take account of such interactions through an ecosystem perspective for ultimate success.

John M. Wenz, USDA Forest Service, Region 5, Forest Insect and Disease Management, San Francisco, CA 94101

A PEST-COMPLEX APPROACH TO FOREST PEST MANAGEMENT

I will approach this topic from a Forest Insect and Disease Management (FIDM) perspective. Our mission is to reduce or prevent damage caused by insects and diseases, commensurate with economic and environmental values, on forested lands of all ownerships. From a practical, pest-management standpoint, the importance of broadly viewing tree-pest interactions should be obvious, but often is not.

The historical approach to forest pest management has generally been a short-term, remedial, direct-control approach aimed at single-target pests; research, too, has tended to focus on single-pest outbreaks. With the emphasis on killing pests, how these pests affect their hosts and the real pest-management objective--preventing or reducing damage--have often been neglected. Understanding how single pests or combinations of pests affect their hosts is crucial to both long- and short-term evaluation, especially in light of increasing emphasis in FIDM on preventing pest

problems. Tree-pest interactions are significant at both the stand and individual tree levels, given the increasingly valued importance of recreational area and tree-improvement programs.

In Region 5, we have developed an approach to pest-related problems called the Pest Damage Inventory (PDI), which considers tree-pest interactions holistically. The PDI measures damage from all pests (pathogens, insects, abiotic factors, or combinations of these agents) in a single survey. First, the pest complex is defined; significantly, this includes collecting associated site and stand data. Second, alternative control or management options and strategies are formulated for each pest or pest complex. Third, the pest-management specialist and silviculturist work together to integrate pest considerations into the silvicultural prescriptions prepared within the context of resource-management objectives. Although the PDI has generally been applied as a survey system to assess mortality and damage caused by forest pests over large areas, it can be used in a variety of ways.

This approach led to including pest-management considerations in the Timber Management Plan for the four southern California National Forests and to initiating attempts to integrate the PDI with the Compartment Inventory Analysis. For example, consider the pest problems in Yosemite Valley. Simply stated, management practices (including fire prevention, meadow drainage, and grazing) allowed dense conifer stands to replace the previously existing meadows and open oak woodlands. This environment favored the initiation and spread of the root disease Fomes annosus, which in turn predisposed trees to bark-beetle attack. Thus, root disease, bark beetles, bark-beetle control attempts (which left freshly cut stumps that enhanced the spread of root disease), and associated management practices, concurrent with intense recreational development and use, created a complex problem situation. The PDI was applied to biologically evaluate the ecosystem; recommended pest-management alternatives included hazard rating of trees, selective tree removal, stump treatment, and eventually, species conversion.

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THE INSECT COMPONENT

Almost all work in forest entomology at any one given time is concentrated on a single insect. This is true for studies on the population dynamics of species as well as in pest-control studies. But the community of insects associated with target species has been generally ignored, and little is known of the community's

role and ecological importance. In our studies, we have long been concerned with the entire insect community but usually only for a single tree species; however, the forest is much more complex. To embark on an ecosystem study, we would have to consider site and stand characteristics of all tree species in a stand as well as data for many other forest plants.

From what we know to date, it is questionable whether a true, long-term ecosystem study is even feasible. Granted, shortcuts can be taken, but some sense of overall complexity is necessary before any lumping occurs. In a northern California study on the effects of insecticides on an insect community occurring on white fir, it took five years just to identify the different insect species. Now, this was only one tree species in the forest--and merely identifying insect species is hardly an ecosystem study.

In a recent investigation of the Douglas-fir tussock moth in California, we tried to include a variety of insects and spiders in our intensive (1/3 of the foliage taken at random on 40-foot trees) sampling of white fir. We totaled 64 species of arthropods on our data sheets, including 8-10 members of the defoliator guild, several predators, and approximately 19 species of spiders. Because sampling was done with a pole pruner and a basket, rapidly moving and flying insects were excluded. Initially, we took vacuum samples of the trees, but the diversity and abundance of insects were overwhelming. We then went to a pole pruner to simplify the work. But we were only sampling 40-foot trees. Because the insects and spiders that we found have different distributions within the crown, multiple sampling techniques may be required to study this group of organisms, posing yet another obstacle to a true ecosystem analysis.

The relationship of the tussock moth to other members of the defoliator guild is not known. Very little is known about its natural enemies and their interaction, and next to nothing is known of the role played by the many other arthropods in the crown. Undertaking such a complex examination poses a major problem to those interested in an ecosystem approach. We could simplify or otherwise stratify the system, but this could lead to major errors in interpretation if not done in an unbiased manner.

Any individual or agency involved in forest management or forest pest control should approach these activities from a holistic (total ecosystem) perspective. Such an approach to management control should result in fewer harmful side effects on a long-term basis.

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HYPOTHESIS TO EXPLAIN THE MODERATE LEVEL OF CORRELATION AMONG WATER STRESS, OLEORESIN PRESSURE, AND SUCCESS OF COLONIZING PINE BARK BEETLES

There is a generally recognized correlation between bark-beetle attacks and water stress in pines. Water stress also correlates with oleoresin pressure (OEP) and with increased soluble carbohydrate concentration in the phloem (Hodges & Lorio, 1969, Can. J. Bot. 47:1651-67). These should increase the likelihood of successful invasion by early arriving (pioneer) beetles and successful brood production, respectively. However, correlations between water stress and OEP, between water stress and beetle attack, or between OEP and beetle attack have not been accurate enough for predictive models of tree susceptibility.

Members of the Biosystems Research group and the Departments of Entomology, Soils and Crop Sciences, and Plant Sciences at Texas A&M have attempted to analyze how these plant physiological factors and beetle behavior interrelate. Based on these efforts, I have formed a hypothesis that might explain these interrelations.

Using a mathematical expression of the principles governing phloem transport (Goeschl, Magnuson, DeMichele, & Sharpe, 1976, Plant Physiol. 58:556-62), we can demonstrate that under water-stress conditions, pressure in sieve tubes can be maintained by decreasing unloading strength, which raises sugar concentration (DeMichele, Sharpe, & Goeschl, 1978, C.R.C. Critical Reviews in Bioengineering, 3:23-91). Thus, turgor pressure in the phloem is not a simple function of xylem water potential, but may be significantly modified by photosynthesis, phloem loading, and sink activity.

If we assume that the xylem ray tissues and epithelial cells lining the resin ducts are in some form of osmotic equilibrium with the phloem, then their turgor pressure will affect phloem functions. These assumptions and their consequences are illustrated in the following table of hypothetical examples.

Tree #	1	2	3	4	5	6
Conditions						
Xylem water potential	High	High	Med	Med	Low	Low
Photosynthetic rate	High	Med	High	Low	Med	Low
Sink strength	High	High	Med	Med	Low	Low
Physiological consequences						
Phloem (and thus epithelial tissue) sugar	Med	Low	High	Med	High	Low
OEP	High	Med	>Med	<Med	Med	Low
Likelihood of successful invasion?	Low-Med	Low	Med-Low	High	High	Low

Now consider the implications of these physiological consequences for the behavior of an invading beetle. After boring through the dry, corky bark layer, the female beetle first encounters the phloem tissue where food values (concentration of sugars, amino acids, minerals, etc.) may influence her subsequent behavior. To establish an egg gallery, the female presumably will sever the radial xylem resin ducts, initiating resin flow. If the food value of the phloem tissue is high, she might be induced to persist in her efforts despite the resin flow (tree #3 in table). Eventual success may result from the collaborative effects of additional female and male beetles or from the symbiotic effects of microorganisms introduced into the adjacent tissues. If the food value is low, the female may not persist (i.e., she may exit voluntarily) even with little or no resin flow (tree #2 and #6 in table). The intermediate conditions offer an array of possibilities.

Thus, although recognizable trends toward lower OEP, higher phloem sugar, and more frequent beetle attacks in water-stressed trees exist, these correlations must be treated as multidimensional interactions. Otherwise, they will remain vague but enticing concepts for predicting tree susceptibility.

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Many hundreds of associations between scolytids and microbes in woody plants could be cited to demonstrate tree-pest interaction. Studying these broad areas of symbiosis offers excellent opportunities to understand fundamental principles regulating insect-microbe-tree interactions which cause damage and death to trees and resultant loss of timber commodities.

Many of the possible interactions are illustrated in the southern pine beetle (SPB)-microbe-loblolly pine phloem/xylem ecosytem (Figure 1). The components of this ecosystem are so interdependent that the term "ecological supra-organism" might well apply. (Time limits of this workshop did not permit listing all available knowledge connecting the various boxes in the figure for the ecosystem or "supra-organism.") Current information was highlighted and promising areas for future study were presented. But several major questions still remain to be answered:

1. What is the controlling mechanism for function of the gland cells associated with the SPB mycangium? What is the chemical makeup of the secretions?

2. What is the chemical bouquet produced by microbes associated with the insect and how do they affect behavior?

3. How does the microbe-phloem interaction affect SPB attack, establishment, and development?

4. What is the nature of the chemical signals from SPB larvae which stimulate the ambrosial fungal growth surrounding the larval feeding chambers?

Answers to these and other questions concerning scolytid-microbe-host tree interactions would provide a broader base for understanding the ecology of the pest in the forest ecosystem.

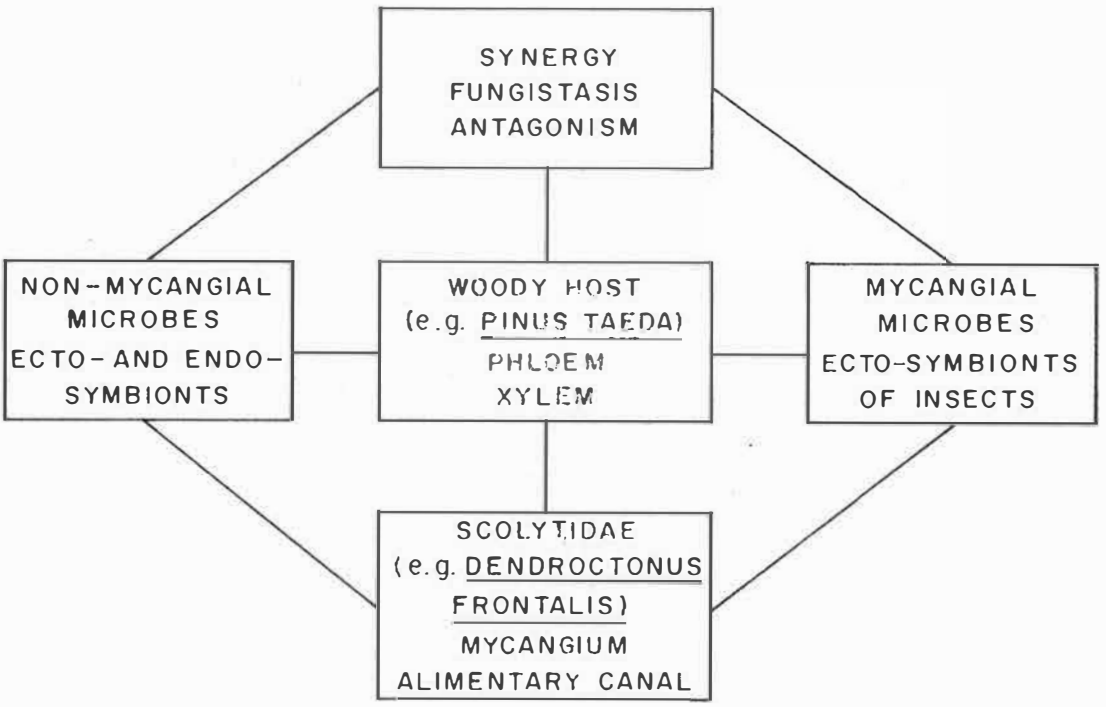

Figure 1. Scolytid-microbe-woody host ecosystem or "supra-organism."

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Researchers historically assumed that plants play a passive role relative to eruptive changes in herbivore populations--an assumption which probably hindered research into the mechanism and causation of such changes. But recent studies have disclosed that both the nutritional quality and defensive posture of plants are affected by physical stress, and that plants can react defensively in direct response to herbivore attack. These discoveries, together with the realization that eruptive changes can significantly affect herbivore population dynamics, signal a new phase in analyzing plant-herbivore interactions. Changes in the nutritional quality and defensive properties of plants are known to affect herbivore mortality and fecundity as well as host susceptibility to grazing. Understanding the factors influencing these changes could reunify the classical and previously unresolved dichotomy between "density-dependent" and "density-independent" effects on herbivore populations.

WORKSHOP: "AN APPROACH FOR ASSESSING FOREST INSECT IMPACTS - RECREATION AND AESTHETIC VALUES"
Moderator: Bill White
Panelists: Dave Holland, Ken Lister, Jim Linnane

The purpose of this workshop was to present an approach, system design, for developing projects and to discuss the output of one such planning effort, An Impact Assessment Proposal.

On November 27-30, 1978 the U. S. Forest Service sponsored a workshop to design a system for assessing the impacts of the mountain pine beetle and the western spruce budworm on recreation and aesthetics in the western United States. Experts in economics, entomology, forestry, landscape architecture, psychology, and biology were invited to participate. For a summary of the meeting see Appendix. The impact assessment system is to become a part of the overall mountain pine beetle/ western spruce budworm management system as it is put into effect.

Participants in the workshop decided that the purpose of the impact assessment system is "to identify the problem, assess the impacts, and determine the appropriate actions." After looking at seven alternative sets of components of an ideal impact assessment system participants selected the following set of components as being most desirable:

Impact Assessment System
1. Biological assessment
2. Recreation assessment
3. Socio-economic assessment
4. People perception assessment
5. Decision making and management

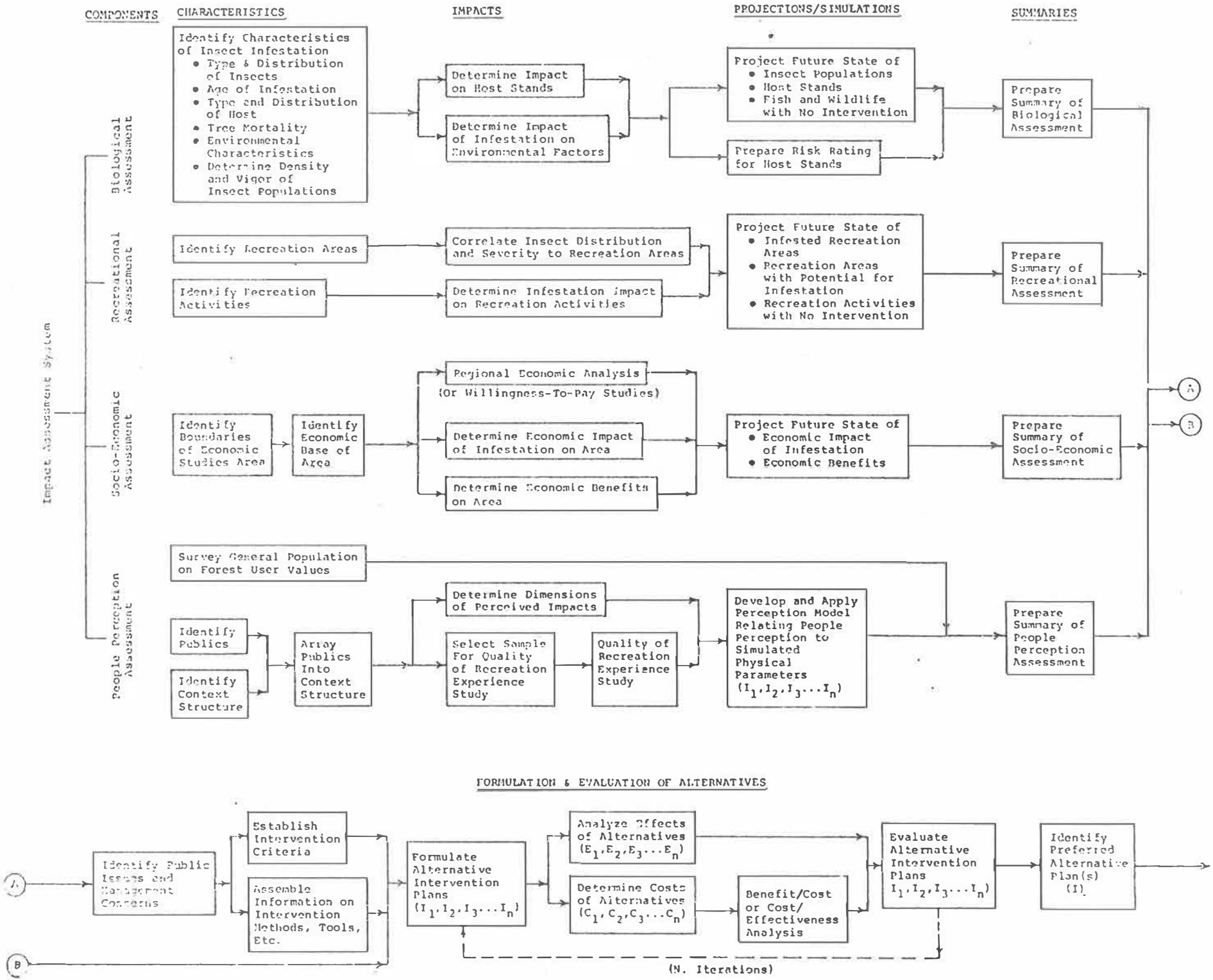
Details were provided for each of the components and an initial attempt was made to interrelate the components. What follows is a summary of the impact assessment system as specified by the workshop and later refined by the U. S. Forest Service FI&DM staff.

IMPACT ASSESSMENT SYSTEM

The initial recommended mountain pine beetle and western spruce budworm impact assessment system (1979-1983) is portrayed on the chart on the next page. The horizontal flow of activities are

organized into the five major components of the system: biological assessment, recreational assessment, socio-economic assessment, people perception assessment, and decision making. Activities are organized vertically into phases: characteristics, impacts, projections/simulations, summaries, and decision making. The chart attempts to portray the interrelationship of system components with only a general reference to time. In actual practice, when the system is implemented many of the studies and steps in decision making will overlap or be conducted simultaneously. Later in the planning process, after more detailed information for each of the activities is developed (through proposals, interviews with experts, and other means) the various sytem activities can be portrayed, with specific regard to time on a Gantt, PERT, or other similar chart.

For present purposes, however, it can be seen from the chart that information will be collected, evaluated, and interpreted in each of the four assessment areas and summarized for use in the decision making process.


COMPONENTS
CHARACTERISTICS
IMPACTS
PROJECTIONS/SIMULATIONS
SUMMARIES
Impact Assessment System
Biological Assessment
Recreational Assessment
Socio-Economic Assessment
People Perception Assessment
Identify Characteristics of Insect Infestation
• Type & Distribution of Insects
• Age of Infestation
• Type and Distribution of Host
• Tree Mortality
• Environmental Characteristics
• Determine Density and Vigor of Insect Populations
Determine Impact on Host Stands
Determine Impact of Infestation on Environmental Factors
Project Future State of
• Insect Populations
• Host Stands
• Fish and Wildlife with No Intervention
Prepare Risk Rating for Host Stands
Prepare Summary of Biological Assessment
Identify Recreation Areas
Identify Recreation Activities
Correlate Insect Distribution and Severity to Recreation Areas
Determine Infestation Impact on Recreation Activities
Project Future State of
• Infested Recreation Areas
• Recreation Areas with Potential for Infestation
• Recreation Activities with No Intervention
Prepare Summary of Recreational Assessment
Identify Boundaries of Economic Studies Area
Identify Economic Base of Area
Regional Economic Analysis
(Or Willingness-To-Pay Studies)
Determine Economic Impact of Infestation on Area
Determine Economic Benefits on Area
Project Future State of
• Economic Impact of Infestation
• Economic Benefits
Prepare Summary of Socio-Economic Assessment
Survey General Population on Forest User Values
Identify Publics
Identify Context Structure
Array Publics Into Context Structure
Determine Dimensions of Perceived Impacts
Select Sample For Quality of Recreation Experience Study
Quality of Recreation Experience Study
Develop and Apply Perception Model Relating People Perception to Simulated Physical Parameters ($I_1, I_2, I_3 \ldots I_n$)
Prepare Summary of People Perception Assessment
A
B

FORMULATION & EVALUATION OF ALTERNATIVES
A
B
Identify Public Issues and Management Concerns
Establish Intervention Criteria
Assemble Information on Intervention Methods, Tools, Etc.
Formulate Alternative Intervention Plans ($I_1, I_2, I_3 \ldots I_n$)
Analyze Effects of Alternatives ($E_1, E_2, E_3 \ldots E_n$)
Determine Costs of Alternatives ($C_1, C_2, C_3 \ldots C_n$)
Benefit/Cost or Cost/ Effectiveness Analysis
Evaluate Alternative Intervention Plans $I_1, I_2, I_3 \ldots I_n$
Identify Preferred Alternative Plan(s) (I)
(N. Iterations)

WORKSHOP: BIOMETRICS IN FOREST ENTOMOLOGY
Moderator: Carroll Williams

The workshop on Biometrics in Forest Entomology discussed some of the statistical problems that most concerned research and pest control entomologists. Some of them were:

1. Proper planning of an experiment or test to examine the most relevant factors within the most appropriate experimental design, power, within specified financial limitations.

2. Uncontrolled variation in insecticide field tests.

3. Data Analyses.

In our workshop we agreed that the best use of an statistician is to enlist his/her aid starting with the planning phase of designing field studies and tests. The analyses and interpretation of the data depend upon the design, the methods used in the experiment, the variability of the experimental material, and the uncontrolled or unmeasured variables encountered in the tests. Proper planning can make a substantial difference between a situation in which the statistician is asked to "salvage" the work, or a situation where the statistician can help the researcher obtain the maximum useful information within available financial resources.

The first step in planning an experiment or a test is to state the objectives clearly, concisely, and as specifically as possible. A statistician can be of great help at this initial point by posing questions to the researcher so that the objectives and scope of the tests are sharply defined. Communication between the statistician and the field entomologist can be enhanced if the statistician can accompany the entomologist into the field and examine the prospective study areas and plots and discuss sampling units and methods on the study sites. After several days of observing and experiencing the field entomologist's work and problems, the advice of the statistician becomes more practical and useful.

The objectives may be treatment effects to be estimated, specifications to be met, or hypotheses to be tested. The purpose of some field tests of insecticides may be to determine the lowest effective dose for each insecticide treatment in the test and to make relative comparisons between treatments. Usually experiments with this general purpose are designed for evaluation by analysis of variance techniques. If significant overall treatment effects are indicated by the F test, tests for differences between pairs of means are the next focus of interest.

In other cases, the entomologist might be concerned with a set of independent evaluations, such as whether each insecticide treatment in the test is effective or not, where the choices between those that are can be made by criteria independent of their relative effectiveness—such as cost, availability, safety and so on. Tests designed to answer this type of question can be based on the assumption that each test represents an independent experiment. Individual t-tests can be used in this situation, where each insecticide is tested against a set standard. For example, will 0.15 lb. of mexacarbate dissolved into a gallon of solvent and aerially applied to an acre of budworm infested trees reduce the budworm population density to an estimated 0.05 budworm/1000 square inches of tree foliage—a standard representing adequate suppression or control of the budworm for the forest?

In choosing the most appropriate experimental design for testing insecticides we must consider the power of the tests, or the probability of detecting differences in treatment effects. Power is the criterion by which confidence is experimental design can be measured. If we designate the hypotheses:

H_o: there are no differences between treatments, or between treatments and control.

H_I: one or more of the treatments differ significantly from the control or from each other.

then we can describe the two kinds of error that can be made in hypothesis testing as shown:

Results of possible decisions in hypothesis testing.

CORRECT DECISION

ACTUAL DECISION

	H_o	H_I
H_o	no error	Type II
H_I	Type I	no error

where

Type I error - is deciding there is a treatment effect when in fact there is none, or rejecting a true hypothesis.

Type II error- is deciding there is no treatment effect when in fact there is one, or accepting a false hypothesis.

The size of the Type I error is referred to as "α" and the size of the Type II error as "β". Then the power of the test is "$1-\beta$", or the probability of rejecting a false hypthesis, in our case equivalent to the probability of detecting a treatment effect when there is one.

For example, suppose we are interested in detecting a difference of 10% in number of larvae killed between two insecticide treatments, and that we erroneously decide that there is no difference when in fact there is a difference of more than 10%. Then a Type II error has been made. If the probability of this occurrence of a Type II error is greater or equal to 20% given the design of our test procedure, then the power of this test is less than 80%. That is, keeping the power above a given level ($1-\beta$) requires keeping the Type II error below "β".

What we always want to do is maximize the power (minimize the probability of making a Type II error) given an initial choice of acceptable size for the Type I error, "α". In a situation where all treatments are considered as parts of an overall experiment or in one where additional factors (such as years) are included, the testing procedures has to be adjusted to provide an "experiment-wise α level" which accounts for the number of possible comparisons and therefore potentially increased number of Type I errors that can be made. Depending on the components of variability and the number of treatments and comparisons in question, the power for this α can become too low to make the decisions reliable enough for practical use.

There are three factors that influence power—variance, cost, and experimental design. For a given sample size, the larger the variance within and/or between sample units, the lower the power. The relation of cost to power has to do with sample size, since increased sample size reduces variance, leading to increased power. One of the major problems confronting the entomologist is to choose the maximum possible sample size within cost constraints. Factors involving experimental design which influence power include number of treatments and the spread of differences between treatments, number of replications per treatment, and number of sampling and subsampling units. Power can be increased by decreasing the number of treatments, by selecting treatment for comparisons with expected large differences in treatment effects—as opposed to small differences. For a given number of treatments, power will increase as number of observations increases.

Data from previous field work can provide useful information on planning future experiments. They may indicate the variability pattern of the experimental material, and the number and nature of treatments. Analysis of variance techniques can be used to help determine where most of the sampling error originates by examining the variance components attributable to each experimental or study level. These can be used in cost functions to either minimize the total cost of obtaining a given variance or in minimizing the total sampling variance for a given cost. This information aids in the development of field work and the selection of an experimental design.

The commonly used experimental designs vary in the way treatments are randomly assigned to the experimental units. Randomization provides the assurance that all treatments have an equal chance of being assigned to a particular study plot. This assures that no treatment would be continually handicapped, or favored in various replications by any bias of the researcher or extraneous variables. Tables of random numbers and computers are commonly used sources of random numbers.

Selection of experimental designs depends upon the objectives and nature of the tests. The plan should be kept as simple as possible and should provide for equal replication, otherwise considerable difficulty can be encountered in analyses, and the resulting estimates can be poor.

Replication assures an estimate of experimental error. It increases precision of estimates of means and the sensitivity of tests of significance. The choice of the number of replications depends upon the degree of precision required, the variability of the experimental material, the magnitude of the differences to be measured, the specified level of significance, and the costs. However, beyond a certain number of replications the increase in precision benefits does not offset the cost of an additional replication.

Because of the high costs of setting up field tests of insecticides relative to the cost of the chemical the tendency was to conduct as many treatments with as many chemicals as was logistically possible and correspondingly the number of replications was severely restricted. Most field tests of insecticides conducted prior to 1965 had only a single replication. Since then replications have been increased to two or three. During the Douglas-fir tussock moth program some pesticide treatments were replicated over several locations and years. Conclusions concerning the efficacy of various treatments are better founded when based on data replicated over space and time. Also information on the interactions of treatments and various environmental factors becomes available using the kinds of repetitions.

One of the final steps in the planning process is a description of how the data will be analyzed. An outline of the sources of variation and degrees of freedom for the analysis of variance should be presented in the plan.

There are four basic criteria that must be met for the analysis of variance method to produce accurate estimates of variance components:

1. The effects of plots, trees, trees within plots and levels within trees must be additive.

2. Variances must be similar

3. The data distribution must be normal

4. The residuals must be random.

It is considered very important to comply with the first criteria if valid estimates of variance components are desired. Sometimes data transformations are necessary, particularly with entomological data since insect population growth is geometric, not arithmetric. Generally, the transformation log (x+1) is suitable for entomological data. When transformations are made it can be informative to conduct an analysis of variance on the original data also to see if there is any correspondence between both data sets. The disadvantage of using transformation is that the comparisons are made and reported on a new scale which is usually not familiar to readers.

Violation of criteria 3 is usually not considered very important, particularly in large data sets whose distributions tend toward normality. Data consisting of averages over several samples are less likely to need transformation than individual observations because data distributions consisting of average also tend to resemble normal distributions.

Much of the invalidity of results of statistical tests arises from unreliable field data rather than from faulty experimental designs. Some field studies are subjected to so much variations due to uncontrolled and unmeasured factors that it is wishful thinking to suppose that the inferences drawn will be valid. This situation prevails in the field testing of insecticides which is heavily influenced by many uncontrolled and unmeasured variables. Some of them are weather, terrain, pilot experience, spray equipment, forest stand structure—number of tree layers or canopies, tree size and species, plot size and configuration, competences of field crew members, as well as the toxicity of the insecticide formulation, persistence of the formulation and spray coverage. However, we usually only quantify the latter three factors.

Data analyses of a recent field test[1/] can illustrate the influence of uncontrolled factors on test results and the importance of adequate replication to counteract some of these factors. Data was examined by regression analysis to see if there were any relationships between insect mortality and 10 variables.

1. Deposit of insecticide on foliage.

2. Deposit of insecticide on aluminum plates placed in forest openings nearest the sample trees.

1/ Williams, Jr., Carroll B., Patrick J. Shea, Bohdan Maksymiuk, John A. Neisess, David McComb
1978. Aerial application of mexa carbate and stabilized pyrethrins on Douglas-fir tussock moth populations. Res. Note PSW-332, 6 p. Pacific Southwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Berkeley, California

3. Deposit on aluminum plates placed in forest openings minus the deposit from plates placed beneath the canopy of sample trees.

4. Number of insecticide drops on cards placed in forest openings nearest sample trees.

5. Number of insecticide drops on cards placed in the open minus the droplet density on cards placed beneath the canopy of sample trees.

6. Insecticide treatment.

7. Study area.

8. Interaction of number 4 and 6.

9. Interaction of number 4 and 7.

10. Interaction of number 4 and 2.

Regression analysis indicated that treatment coverage accounted for most of the variability in insect mortality. 1/ Insecticide treatment was not related to mortality unless it interacted with spray droplet density. This would tend to support the hypothesis that either all of the insecticide treatments were of equal efficacy, or that the tests were confounded by nonequivalent application procedures.

Results also suggested that area was an important variable 1/. The significance of this may be that no comparisons can be made among insecticide treatments because they were not applied under comparable geographic forest stand, and meteorological conditions. This suggest inadequate treatment replication in the experimental design.

In conclusion, participants in the workshop believed that coping with the relationships between data variance, cost, experimental design, "power", sample size and treatment replication remained among the most important biometrical problems of the forest entomologist.

WORKSHOP: EFFECTS OF COOPERATIVE FORESTRY ASSISTANCE ACT ON FOREST INSECT AND DISEASE RESEARCH AND FOREST INSECT AND DISEASE MANAGEMENT
Moderator: Don Graham

The Federal Forest Pest Control Act of 1947 was repealed by Congress in the fall of 1978 and replaced by Section 5 of the Cooperative Forestry Assistance Act. Forest Insect and Disease Management (FIDM), who more or less administers the Act at the field level, either independently or in cooperation with the States, lost none of their former authorities and gained three additional authorities. They are:

1. Provides for carrying out activities, including survey, evaluation, prevention, and suppression, to protect trees from insects and diseases. The former Act spoke only to "forests."

2. Provides for management and coordination on pesticides and their use to forests, trees, other vegetation, wood products, stored wood, and wood in use.

3. Provides for carrying out activities, including survey, evaluation, prevention, and suppression, to protect wood products, stored wood, and wood in use from insects and diseases directly for the National Forest System and in cooperation with others on non-Forest Service lands.

Rules and regulations for administering these additional authorities have not been issued.

Workshop discussions centered around number 3, above; that is, protection of wood products, stored wood, and wood in use. However, some discussion of number 1 (protection of trees) took place.

The objective of the workshop was to exchange ideas on the need for an accelerated program by the Forest Service/State cooperative program that would cover survey, evaluation, and technical assistance on insects and diseases of wood products, stored wood, and wood in use. The objective was not to reach any conclusions. Such questions as those below were discussed.

--Does this new authority merely give us a legal means to do what we have been doing?

--What is current research underway in the West in this area and is additional research needed?

--Is there an identified job out there that needs doing, but is not getting done; if so, what is it?

--How should we work with State/Federal Extension Service, Animal and Plant Health Inspection Service, and Pest Control Operators who each have activities or authorities for pests of wood?

It was stated that interim Forest Service policy is to restrict activity on pests of wood to incidental assistance that can be carried out with current resources until need is identified and funding needs can be reflected in the budget cycle. Any accelerated effort by the Forest Service and participation by cooperating States in the future should be in addition to, rather than replacing, current forest insect and disease responsibilities.

Most attendees felt that the degree of emphasis needed on "pests of wood" may be very regionalized according to local situations. Most attendees did not feel very comfortable about knowledge on the need for an accelerated effort and the benefits that would accrue. No attendee seemed highly concerned about jumping on any bandwagon. The general attitude was to move slow.

Every attendee was given the opportunity to express their thoughts or views and did.

WORKSHOP: ROLE OF SILVICULTURE IN REDUCING LOSSES TO MAJOR WESTERN FOREST INSECTS

Moderator: Mike Cole

This workshop focused on silvicultural opportunities inherent in most of our major western forest insect problems.

Dr. Karel Stoszek began the discussions with an illustrated review of some obvious, as well as not-so-obvious, ecological relationships that the forest manager influences, and therefore should consider, in the course of applying silviculture--whether prompted by insect problems or any other management concern. John Kwader discussed the importance of timely silviculture in preventing and reducing losses to insects. He drew a strong distinction between the complexity of problems in dealing with defoliating insects in contrast to problems with the major bark beetles--the severity of which is largely influenced by large areas where timber management has not been, and in some cases cannot be, practiced. Bill Wulf endorsed the principles set forth in Karel's illustrations and informed that recognition of them was embodied in the silviculture studies of the Canusa Spruce Budworm Program which is designed to provide clearer silvicultural guidance for handling this defoliator.

General discussion within the panel and among workshop participants was keyed to the following outline, which was reiterated at the end of the session to summarize the discussions and provide in conclusion a simple conceptual framework for managers to use in considering insect problems and silvicultural options available to address the problems:

Common Problem Elements And Silvicultural Responses
Germane to Many of the Major Insect Problems

I. Insect problems can be increased by some of the following management decisions or effects associated with them. In your experience, what pest management or silviculture responses are available for the specific problem? Are they compatible with each other and the ecosystem in general?

- Increased tree damage or mortality from harvesting, regeneration, or TSI practices (windthrow, scorched trees from slash burning, soil compaction, etc.)
- Excessive slash accumulations
- Off site species
- Timing and scale of cultural practices
- Overmaturity and stand decadence
- Contemporary stress, as from drought, ice and snow storms, flooding, etc. Are some of these effects intensified by management? How can they be modified or ameliorated?

II. What practices among the following will concurrently provide favorable conditions for attaining growth and yield objectives of management, but unfavorable conditions for the insect increasing its damage effects?

- Stand density control
- Manipulation of species composition
- Creation of age, tree size, and species diversity (large scale connotation)
- Employing genetic resistance

III. What practices are available for preventing losses, or reducing or mitigating losses otherwise not prevented?

- Sanitation cutting
- Salvage cutting
- Other

WORKSHOP: AERIAL APPLICATION TECHNOLOGY
Moderator: Robert Ekblad
Panelists: Robert Banaugh
Alan Bullard

AERIAL SPRAY MODELS (Robert Banaugh)

The objective in developing a model of an aerial spray is to provide a tool for improving the overall efficiency of an aerial spray appli-cation. Such a model must include a knowledge of spray physics as well as a knowledge of the biological impact of the spray. Presently, nearly all model development efforts have concentrated on describing the phys-ical behavior of the spray. Very little work has been done on including a description of the biological impact. In this paper the term biological impact consists of the impact upon the pest together with the impact upon the environment of the spray.

The physical description of the spray has resulted in the development of two classes of spray models; diffusion based and ballistic based. Diffusion based models derive from assuming that diffusion is the process governing the behavior of the collection of droplets comprising the spray. Thus, diffusion models describe the time and spatial dependence of the variation in the concentration of the droplets. In contrast, ballistic models, also called trajectory models, describe the motion of a single particle. The overall behavior of the spray is then obtained by properly averaging the individual behavior of a sufficiently large number of droplets.

It is the consensus of spray physicists that ballistic models are more appropriate descriptions of sprays comprised of large droplets, i.e. droplets whose diameters are larger than two microns. On the other hand diffusion based models are thought to be more appropriate for predicting the behavior of sprays which consist of small droplets. This consensus is not unanimous nor is there strong agreement on what is the "cut off" diameter separating the two types of description.

If these destinctions are valid it follows that a ballistic model should be used for describing the behavior of the early time history of the spray, that is from the time the droplet leaves the nozzle until the time the droplet passes through the vortex field and enters the target area. It also follows that a diffusion model should be used to describe the behavior of the spray until the time the spray comes to rest beginning with the time the droplet has left the vortex field or when the droplet has become sufficiently small. These two problem areas are sometimes called the application problem and the drift problem respectively.

Future Research and Development Needs

1. The physical principles governing the behavior of aerial sprays are well known; however, there is a difinte need for the obtaining of data with which to validate models developed from these principles.

2. There is a need to develop calculational methods for describing the canopy penetration of a spray. The Barry-Grim technique is very promising and experimental data is needed to calibrate the technique. Equally important is a calculational method for determining the degree of biological control achieved by a spray.

3. There is a great need for determining the degree of pest control achieved by a particular spray. Included in this problem area is a need for determining the optimum bacteriological, biological and/or chemical constitution of a spray to achieve a prescribed degree of pest control.

4. There is a need for a quantitative measure of assessing the degree of biological impact.

5. There is a need to include biological impact in the models. After all, the purpose of the spray is to achieve a biological impact and it, therefore, must be the purpose of the model to describe and predicT the biological impact. Both the canopy penetration calculation and the biological control calculation will have to be properly coupled.

6. There is a need to validate the "complete" model described in item #5. The validation will require the use of sophisticated sampling methods since the acquiring of the necessary data will be time consuming and expensive.

7. There is a need to include climatological and aerodynamic effects in the models. Examples of the former are turbulence and wind conditions while examples of the latter are vortex fields generated by the moving aircraft. Other relevant effects that should be included are droplet evaporation rate, temperature distribution and humidity.

MARSH TURBO THRUSH DEMONSTRATION (Alan Bullard)

The following presentation is a summary of the results from a demonstation of a Marsh Turbo Thrush aircraft, conducted in July and August 1978. The demonstration was held in the vicinity of McCall, Idaho. Jack Barry (MAG) supervised the project, and was assisted by Jerry Knopf (R-4) and George Markin (PSW). The demonstration objective was to evaluate the suitability of the Marsh Turbo Thrush aircraft to apply pesticides in mountainous coniferous forests. Prior investigation had already established the suitability of the spray characteristics of this aircraft for forest applications (Barry et al. 1978)[1/].

The Turbo Thrush was operationally tested on 6 plots of 500 acres (200 hectares) each. Since the helicopter has been the primary vehicle for application of pesticides to the mountainous forests, a Bell 206B Jet Ranger was flown on these plots to serve as a standard for evaluation of the performance of the Turbo Thrush. The initial interpretations of this demonstration are as follows:

1. The addition of turbine power to ag aircraft, as represented by the Marsh Turbo Thrush, has improved fixed-wing performance in the areas of payload, operating speed, and maneuverability, which had been problems previously associated with fixed-wing operations in mountainous terrain. The Turbo Thrush operated quite safely during this demonstration at spray elevations of up to 7,000 feet MSL.

2. Based on spray time per plot, the Turbo Thrush was nearly twice as efficient as the Bell 206B. This was due to the higher operating speed and the wider swath width generated by the Thrush. This increase in efficiency would allow longer ferry distances with no increase in total time to spray over those distances/times associated with rotary-wing operations.

It must be pointed out that these are preliminary indications only, and that data analysis has not been completed. It also must be stated that this demonstration utilized only one turbine aircraft and one pilot. This report should not be considered a blanket endorsement of Turbo Thrush aircraft or operators. Based on this demonstration, however, the Forest Service should consider bids from Turbo Thrush operators and not limit bid submissions to helicopters.

1/ Barry, J.W., G.L. Whyte, and T.H. Hofacker. 1978. Evaluation of the Marsh Turbo Thrush for forest spraying. Phase 1 - Spray characterization. Rpt. No. 79-1. USDA Forest Service, Forest Insect and Disease Management, Methods Application Group, Davis, CA. 33 pp.

WORKSHOP: SHRUB INSECTS
Moderator: Charles F. J. Tiernan
Participants: Steve Monsen, Bill Barr, Mal Furniss

There is a need for entomologists to study insects associated with shrubs in all natural resource areas (forest, range, wildlife, watershed and recreation). Nearly all shrub species are insect-pollinated, so pollination and seed production are high-priority needs. Forest shrubs may act as reservoirs for natural enemies of insect pests in overstory trees. All wildlands act as reservoirs for harmful and beneficial insects which can migrate to adjacent intensively-managed lands. A serious problem may be that harmful insects easily escape to and adapt to these intensively-managed lands, but there is inadequate habitat there for parasites and predators. Common examples of this type of situation exist with agriculture crops, forest plantations, tree and shrub seed orchards, and rehabilitated rangelands dominated by crested wheatgrass. Man's desire to revegetate areas only with the most desirable plants may upset the natural sequence of plant succession and provide adequate habitat for certain insects, but not their natural enemies. Parasites and predators have other habitat requirements when not directly associated with their hosts.

Steve Monsen spoke on management's need for shrubs in efforts to revegetate and rehabilitate disturbed areas in the west. Common disturbances are strip mines, overgrazed rangelands, burned areas, watersheds, highways and forest roads, big game winter range, power transmission line strips, recreation areas and land being subdivided. Early attempts have concentrated on grasses and trees. He felt that a complex of grasses, forbs, shrubs and trees locally adapted was needed to provide a balance to the environment and that there is a need to include insects in the work. Steve's work is strongly concerned with shrub selection. Shrub gardens located in Utah, Nevada, Idaho, Oregon and California are centers for gathering and comparing traits of shrub ecotypes representative of the region. Shrub species of particular interest are sagebrush, rabbitbrush, bitterbrush, saltbush, blue elderberry and cliffrose. Greatest problems are the supply of seed and nursery stock for outplanting. They do not consider insects unless there is an obvious problem.

Bill Barr gave a general account of insects associated with shrubs. The dominant plant genera under consideration in southern Idaho in the Chenopodiaceae are Atriplex (3 spp.), Sarcobatus (1 spp.), Eurotia (1 spp.), Grayia (1 spp.), and Kochia (1 spp.); in the Compositae are Artemisia (5 spp.), Chrysothamnus (2 spp.), Tetradymia (3 spp.), and Gutierrezia (1 spp.). The dominant insects, by plant habitat, which are currently receiving attention are borers (Coleoptera and Lepidoptera), defoliators (leaf--Coleoptera, Lepidoptera and Orthoptera; bud--

Lepidoptera), sapsuckers (aphids, scales and mealybugs), gall-formers (mostly Diptera), and gatherers (harvester ants). Dr. Barr made some generalizations about shrub insects. 1) There is a high degree of host specificity reflected in intermittent and cyclic occurrence of plant mortality, and 2) a restricted and localized occurrence of insects termed a "rarity of insect species." There is rich diversity in the gene pool of both shrubs and insects on wildlands as they evolve together.

Mal Furniss reviewed some of his specific research on insects associated with red-stemmed Ceanothus, a valuable browse species to big game animals. He dealt with the bionomics of a tiny wasp responsible for inhabiting and destroying seed of red-stem. Accompanied by excellent slides of plant parts and insects close up, he described the life cycle of the wasp and unique procedures using X-rays to distinguish sound seed from insect-infested seed. Results of this work can be found in the proceedings of First International Rangeland Congress (1978). Some in the audience expressed a desire for more discussion on shrub insects.

WORKSHOP: IMPLICATIONS OF THE NATIONAL FOREST MANAGEMENT ACT (NFMA) ON FOREST INSECT AND DISEASE MANAGEMENT

Moderator: William M. Ciesla

Bill Ciesla opened this workshop by reviewing the legislative history of NFMA, its structure, and provisions.

Action ultimately leading to the passage of NFMA had its origins in controversy which originiated with the landmark decision of Issac Walton League vs. Butz, and found certain forest management practices on the Monongahela National Forest in West Virginia in violation of the Organic Act of 1897. This early legislation, the basic authorization for management of National Forest land, states "Only dead, mature, or large growth of trees may be sold for harvesting", and "All timber must be marked and designated prior to being sold".

Literal interpretation of the Organic Act limited certain timber management practices, including clear cutting (unless all trees were marked), removal of poor quality, immature stands, or thinning and other intermediate cuttings, and raised the issue: Is it in the public interest to legislate forestry practices?

Several pieces of legislation were introduced in Congress to update the Organic Act. These included an interim bill to provide emergency authorization to administer timber sales for a two-year period to allow Congress to study the issue, the Randolph Bill, which prescribed certain silvicultural practices and curtailed others, including clear cutting east of the 100th Meridian, and the Humphrey Bill (S-3092) which provided a series of amendments to the Forest and Range Land Renewable Resources Planning Act of 1974 (RPA), and the Organic Act. This Bill provided for prescriptions and guidelines to be implemented through regulations developed by the Secretary of Agriculture rather than legislative mandate. The Humphrey Bill became the NFMA, October 1976. NFMA is structured into 21 sections. Sections 2-12 amend the RPA, and Sections 13-15 amend timber sale provisions of the Organic Act. Other sections provide for minor updating of other legislation, and a plan for control of Dutch Elm disease.

Highlights of NFMA include:

Section 4 - Reforestation

This section establishes as Congressional policy that all National Forest System lands shall be maintained in appropriate forest cover and provide $200,000,000 annually for reforestation and timber stand improvement.

Section 6 - National Forest System Resource Planning

This section is the largest addition to RPA, and the most significant in its impact on National Forest management. It makes the land management plan the basic institution for management of the National Forests.

National Forest plans are to be completed by September 30, 1985. The planning process is to involve full public participation and review, and be coordinated with other state and Federal agencies.

Plans are to provide for multiple-use management, and be prepared by an interdisciplinary team. Regulations for preparation and revision of land management plans are to be developed. The Secretary of Agriculture is authorized to appoint a committee of scientists outside the Forest Service to provide scientific and technical advice on regulations and procedures.

Section 11 - Limitations on Timber Removal

This section limits timber removal from a National Forest to a quantity not greater than that which a forest can produce in perpetuity on a sustained yield basis. The Secretary of Agriculture is authorized to exceed this level from time to time, as long as this level is maintained for each National Forest for any 10-year period. This establishes the principle known as non-declining even-flow.

Ron Stark, University of Idaho, reviewed the work of the Committee of Scientists in developing regulations for Section 6. Stark was one of seven members of this Committee, which was appointed by the Secretary of Agriculture in May 1977.

This team was initially asked to write the Section 6 regulations; however, this later became a team effort with Forest Service officials taking the lead. First draft was published in the Federal Register, August 31, 1978.

The Committee of Scientists subsequently conducted an intensive review of the draft regulations, and concluded that they would require considerable strengthening in a number of areas. A 158-page report has been prepared and submitted to the Secretary of Agriculture. This report, plus comments from the general public, will be published concurrently with a second draft of the Section 6 regulations during April 1979.

General direction in preparing the Section 6 guidelines was not to be overly prescriptive, but to give the land manager flexibility to meet local on-the-ground conditions.

When completed, National Forest plans will provide the basis for land allocation and identification of resource system capabilities. These are aggregated at the Regional and National levels and are the basis for targeting of outputs by resource systems. These targets are disaggregated back to Regions and Forests from the National level.

FI&DM aspects of National Forest planning are not discussed in-depth in the current version of the Section 6 regulations. The Committee of Scientists has recommended that protection and preservation from pests by ecologically compatible means be the principle to guide incorporation of pest management practices into forest plans, and has proposed inclusion of a definition of integrated pest management in the Section 6 regulations. This concurs with the Secretary of Agriculture's policy memo number 1929 stating that IPM be a guiding principle in USDA.

Numerous other weaknesses occur. For example, under the first draft regulations, only two specialists would satisfy the requirements of an interdisciplinary planning team. The Committee of Scientists recommends incorporation of guidelines to permit participation of outside expertise on planning teams if the expertise is not available in-service.

NFMA, when fully implemented, will significantly change the way the Forest Service conducts its business. It is the first piece of legislation that provides for making the means by which a Federal agency regulates itself highly visible to the public.

FI&DM representatives from several Regions and Areas reported on how NFMA is affecting their program operations. A "lead" forest for planning under NFMA standards has been selected in each Region. FI&DM has been involved in the planning process to varying degrees, and in each case, FI&DM specialists have had to make initial contact with the planning team in order to insure that insect and disease considerations are incorporated into the forest plan.

In Region 1, all stands on the lead forest have been rated for relative risk of bark beetle infestation. In addition, a narrative report describing past forest insect and disease conditions is being prepared for the planning team. A total committment of ½-man-year of FI&DM staff time is anticipated for participation in the planning process.

In R-2, FI&DM specialists are working with the lead forest but the planning team has not yet identified data requirements. FI&DM specialists have risk-rated spruce forests on the Chugach National Forest, R-10's lead forest, for susceptibility to spruce bark beetle. In the SA, initial contact with the lead forest has been made by FI&DM, but specific data requirements have not been identified by the planning team.

To date, there have been no instances where an entomologist or pathologist has been a full member of a core planning team. Data has been provided to the core team by FI&DM specialists for integration into the overall forest plan.

One of the biggest challenges facing FI&DM today is to convince the planning teams that insect and disease management is an integral part of the implementation of NFMA. FI&DM specialists should be aggressive in integrating I&D considerations into the forest planning process.

WORKSHOP: MAKING AERIAL SURVEYS MORE USABLE TO FOREST RESOURCE MANAGERS
Moderator: LeRoy N. Kline
Participants: About 20 people attended. Key participants were myself, Ladd Livingston, Paul Gravelle, Bob Dolph, John Harris, and Bob Heller.

Discussion was very informal and followed the format of a true workshop.

Although the title of the workshop and the theme of the Conference concerned the resource manager, participants felt there were other users of aerial survey maps and data. They were identified as pest managers, administrators and politicians, environmentalists, and reporters of various news media.

Before we can make aerial surveys more usable, we have to determine what the user needs or how he is presently using or not using the survey. Some of the main uses of the maps and data that were identified are as follows: 1) Immediate and short term plans for salvage of mortality, 2) Long term planning and projecting timber supply, 3) 5-year action plans, 4) Setting priorities in assisting private landowners by State Service Foresters, 5) Industrial landowners scheduling special aerial flights or ground checks, 6) Management problems in designated parks, roadless areas, wilderness areas, or those areas being considered as such under RARE II, 7) Historical records of trend of damage by species of insect, location, intensity, and damage, 8) Reporting accomplishment and accountability-timber saved versus timber loss, 9) Determining location of high-risk fuels (hazard rating) for fire prevention and suppression, 10) Information for lobbying for funding of pest management and research, 11) Public information and inquiry.

Ways to improve the survey and how it is used were discussed. Some of the suggestions were: 1) To obtain more accuracy in location of problem, as this seemed to be the most important use, 2) Improve accuracy of degree of damage, 3) Send the maps and data out to the users sooner, so action can be taken within the same season, 4) Record other types of damage such as animal, weather, etc.

The workshop concluded with a slide presentation by John Harris on some aerial techniques and studies in Canada. His summary, which would also apply in the States is as follows:

In the B.C./Yukon Region of Canada an annual overview of forest pest damage is obtained from aerial surveys done by staff of the Forest Insect and Disease Survey, Canadian Forestry Service. Sketch-mapping from small aircraft is the basic method used, flying along valleys, guided by previous experience. Dying trees usually are counted, and defoliated areas are outlined, on maps.

Sketch-mapping is sometimes supplemented with hand-held, oblique color aerial photography. Comparisons between sketch-maps and photographs of the same areas showed that sketch-mappers overestimated defoliated areas visible on photographs and underestimated counts of killed trees. Counts by observers from projected slides of infested forests showed considerable variation in numbers.

Sketch-mapping and photography should record the same data although both miss trees hidden from the air. Factors affecting sketch-mapping accuracy include observer experience, training, fatigue and available air time. Problems with photography include difficulty in discerning light defoliation and subtle color changes due to haze and smoke, scale and film exposure. The ideal surveys involve a combination of sketch-mapping and photography, with need for precision and costs the controlling factors. Training of observers is essential.

WORKSHOP: BUILDING INSECT CONSIDERATIONS INTO LAND MANAGEMENT PLANS
Moderator: Mark McGregor

The workshop included National Forest, Bureau of Land Management, State, and private managers.

Forest Plan and the Use of Insect and Disease Data,

M. D. McGregor, U.S. Forest Service, Missoula, Montana

It has been a challenge to get managers to implement insect and disease input into land management planning. The responsibility, however, should not rest totally with the forest manager. Reasons for insect and disease data not being considered in past years may be (1) poor information being collected, (2) good information being collected, but not written in a form usable to land managers, (3) poor cooperation between Research and Insect and Disease which has prevented usable data from being passed on to the land manager, and (4) reams of valuable data laying stagnet in files.

FI&DM has the responsibility to aid land managers in implementing research findings. This can be done through pilot tests, establishing demonstration areas, and administrative studies. It may also involve FI&DM units doing some phases of the job for land managers to show the feasibility and value of research findings.

Recently in the U.S. Forest Service, Northern Region, in Montana we have cooperated with a number of Forests in implementing risk rating lodepole pine stands for hazard to mountain pine beetle infestation. It was first necessary to risk rate some stands to show the validity of risk rating. Then many National Forests, as well as State and private concerns, began doing it for their forested stands.

The value of risk rating was recently realized on the Tally Lake Ranger District, Flathead National Forest, Montana. Stands were roughly hazard rated on timber type maps by FI&DM. District personnel then submitted a project proposal to FI&DM for financing and visited 5,000 lodgepole pine stands where they collected stand data; i.e., slope, aspect, elevation, tree species, average tree age, average tree diameter and growth, habitat type, stand density by species, and merchantable volume. These data were then used to risk rate the stands. Data showed that there were 38,000 acres of high risk lodgepole pine containing 320 MMBF merchantable volume (Figure 1).

Meetings were set up that involved Federal, State, and private intermingled land owners and timber companies to develop an action

plan for management of not only the 38,000 acres but adjacent forested lodgepole pine stands. Each respective land manager was given the responsibility for management of their lands. The management team for the National Forest included engineers, soil scientists, wildlife biologists, landscape architect, timber planner, fire management, entomologists, and Rangers, and the Forest Supervisor's staff.

Using the data available from the stand examination, the team put together a management plan to prevent infestation in the high risk stands by logging 160 MMBF within 3 years. Annual monitoring for infestation will determine if the remaining 160 MMBF will need to be logged within the same timeframe. Removal of the high risk stands will prevent mortality of moderate and low risk stands. A coordinated effort from all managers will prevent infestation from developing in high, moderate, and low risk stands.

In working with our lead Forests, major changes have occurred in planning concepts. This change is indicated by two requirements of the regulations proposed for implementing the National Forest Management Act.

1. Regulations require that a monitoring plan be developed to evaluate the results of activities implemented by the Forest plan. If through monitoring we find our projections are not correct, there is a procedure to revise the plan. This will not only insure that the plan does not sit on the shelf, but it will also provide criteria to evaluate the performance of the plan.

2. Regulations indicate that some form of computer modeling is required to meet the intent of the regulations. Although some modeling has been undertaken for specific problems or areas, this will be the first attempt to systematically model all the Forests in the United States. It will also result in a uniform data base, at least regionally, which has not been available heretofore. The impacts of this concept are far-reaching in our ability to respond to budgeting problems, special requests, and projecting into the future.

How will the Lolo National Forest incorporate and use insect and disease considerations in the Forest plan?

Efforts in this area are still underway with some process steps to be formulated. Conceptually, information will be developed to assess the present situation and a risk rating system will be formulated for evaluation of the proposed alternatives.

In selecting the alternative for the Forest plan, consideration will be given to the impact of the expected insect and disease problems inherent to the alternative.

To date, the following information has been developed:

--Synopsis of major insect and disease problems on the Lolo.

--Risk rating by habitat group by insect or disease agent.

Presently under development is:

--Attempt to relate risks to time, or age classes, to put into the model.

--Proposed process for development and use of this risk factor is:

Map Forest into "risk" classes (actually some sort of descriptive information) based on the Forest P.I. (photo identification) types. Since we could not afford time to do this by hand, a computerized mapping system is being developed under contract and should be available in a couple of months.

When this information is available, personnel from Forest Insect and Disease Management will try to establish a way to estimate the effects of alternatives. This will involve analyzing risk relative to management prescriptions. For example, for an area allocated to roadless, factors to be considered will include the effects on insect and disease risk of allowing a natural rotation both in the area and effects on adjacent areas, or an area with a VQO (visual quality objective) of "Retention" will have a longer rotation age. How will this affect insect and disease risk factors?

The Insect and Disease Index called for in MIH (Management Information Handbook), like the Fire Management Index, is on the order of an index of cost/benefit. This appears to be adequate for budget considerations after the plan is implemented, but does not appear adequate to account for insect and disease considerations in allocation decisions.

We are in the final steps of loading our data base and have begun our editing routines. During March, model formulation will be well underway with at least some alternative development begun.

At that time, we will attempt to finalize the process that will be used in the insect and disease management evaluation techniques.

How Boise Cascade Corporation Builds Insect Considerations into Land Management Decisions, Cy Shrider, Forester.

Cy confined his comments entirely to Boise Cascade Corporation and its operations. By way of introduction, Boise Cascade Corporation is a large concern with over $2 billion of sales annually. There are four basic operations, all wood related. These are paper, building materials, packaging and office products, and wood products. Included in the wood products portion of their operations are fee timberlands totaling about 2,700,000 acres. The purpose of these lands is to help supply their mills and to provide a profit to the stockholders. They are roughly 50% self-sufficient, that is, the fee lands will supply about 50% of the needs of their wood products and paper mills. The balance of wood comes from outside purchases, primarily National Forests, State forests, Bureau of Indian Affairs, Bureau of Land Management, and other private owner holdings. Boise Cascade operates in almost every timber producing area in the country. They have lands on the Pacific Coast of Oregon and Washington that are basically hemlock and Douglas-fir. They operate in the Intermountain areas of Idaho, eastern Oregon, southern Oregon, and eastern Washington. They have lands in the Midwest in the States of Minnesota and Wisconsin, lands in the South, both fee and those included in a joint venture concern called Boise Southern, and lands in the State of Maine. In addition to this, they also, through Boise Cascade Canada, have licenses in the provinces of Ontario and New Brunswick. These are lands controlled by the Province, and they simply buy timber from these lands. In the near future, it is highly likely that the timber license holder will become more responsible for operations on those licensed lands. In other words, there will be more control over where cutting is done, when to cut, and the responsibility for reforestation and other forestry operations. In addition to these lands, they acquire timber from various private owners. They have a Land Owner Assistance Program wherein they provide a timber inventory and develop a management plan incorporating the owner's needs from his lands. They provide this to the owner free of charge with the only restraint that when he sells his timber he must bring it to them for a right of first refusal. From the listing given, Boise Cascade has diverse timberlands and therefore many diverse timber types which gives them a number of diverse operational and insect problems. Insects can impact them in two ways. First, as their lands are managed, they also acquire additional lands in the course of the operation and the extent of an insect

infestation will determine the price or value. In some cases, it will determine whether they even want the lands at all. For instance, if the properties were under a heavy spruce budworm or mountain pine beetle attack, it's conceivable they wouldn't wish to buy them at all. The other impact is on forest management. Boise Cascade's philosophy of management is that they will control insect attacks by insecticides, if it is possible both biologically and politically. As you are well aware, there are many things that are practical biologically that are not possible politically. Failing in any kind of control, they will salvage the dead and severely attacked. Their premise is that they would rather harvest the tree than hope that it might recover. This is for several reasons. Risk of loss is quite high on an infected tree. Once the tree is dead, it may not be salvageable. If an attacked tree is left and several other are taken out around it that have been killed, it is impractical to come back and log the remaining stand as the volume per acre is so low that it may be impossible to salvage any of the timber. Even if the tree survives, it is likely that the growth rate has been reduced to the point where it is uneconomical to retain that tree. They would rather replace those slow-growing trees with a fast-growing forest. In addition, there is an impact on both present and future annual cuts. Recently Boise Cascade has been using RAM, a Resource Allocation Method, to judge the effects and the economic analysis of various cuts, silvicultural operations, etc., as a means of determining the allowable cuts. One advantage they have is that as a private company, in spite of government intervention, they have a fairly high freedom to operate and they have the financing available to fund the operations they feel are necessary. In general, management points to shorter rotations to develop a younger, healthier forest which is better able to resist attack. Silvicultural programs are pointed toward stocking control for faster individual growth and healthier trees.

As an example of this, in the silvicultural program in the Intermountain Area, Boise Cascade practices selective cutting which removes the overstory and thins the understory. This is followed by precommercial thinning to provide proper spacing. In each of the operations, they attempt to perpetuate a mixture of species. This provides more space between susceptible trees, that is, trees that are susceptible to a specific insect, plus a general improved health and resistance. In the last 5 years in the Intermountain Area, some 51,000 acres have been specifically treated which, including harvest on another 60,000 acres,

covers about 10% of the lands available. The biggest problem in precommercial thinning is that if there are trees that are too small to be merchantable and yet are too large for precommercial thinning, about all that can be done is to simply leave them alone until they become merchantable.

A concerted effort is being made to log the hot spots of attack. Specifically, in mountain pine and southern pine beetle attacks all the dying trees plus the likely candidates in an area around the hot spot are taken out. Shrider's personal opinion is that Boise Cascade's program in southern Idaho has prevented a blowup such as is occurring in eastern Oregon where there was no concerted cut and no attempt to really try to get out ahead of the insect. Shrider has seen several aerial photographs where stands that have been precommercially thinned have no beetle attack while the surrounding areas were heavily hit.

In summary, Boise Cascade's land management program is adjusted by the insects. They rely partly on the judicious use of insecticides, but their primary reliance as far as the company is concerned will be long-term harvesting and silvicultural controls using shorter rotations. One thing Shrider emphasized is that silviculture also includes harvesting. He happens to be a believer in the old adage learned in forestry school a number of years ago that forestry begins with the ax. Land managers need help from the specialists, from entomologists, because they don't have the in-house expertise. They need more information on life history and the expectations for control. Once they determine this and they have a definite control measure to undertake, you can be assured that they will be able to act and act quickly.

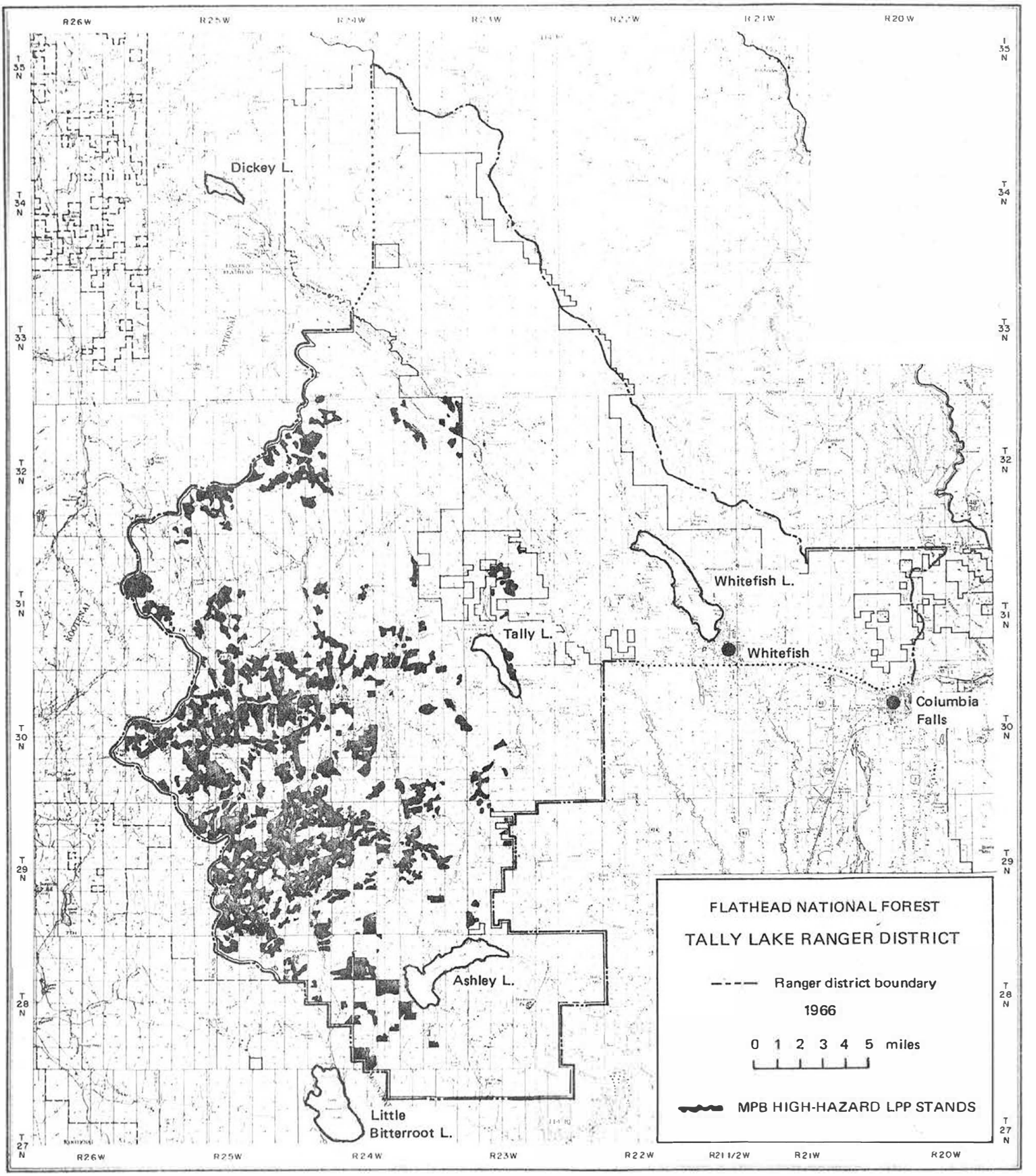
Building Insect Considerations Into Land Management Plans State of Oregon Status, Al Larsen, Oregon State Department of Forestry

The Oregon Department of Forestry's principal responsibilities, by law, are with the State and private lands in Oregon. While the State of Oregon manages only about three-quarters of a million acres of forest land, it provides fire protection and other services to the private landowners on some 11 million acres of private forest land.

The Department has been involved in insect and disease since the early 1920's, with principal emphasis on control. However, it was not until the 1950's that the Department started building up

an insect and disease staff. The first entomologist was not added to the staff until 1965, followed by a forest pathologist in 1970. There are now two entomologists, a pathologist, and two technicians, in addition to the program director. The second entomologist has just been added in the eastern Oregon area, and the Department has budgeted for two additional insect and disease foresters to assist him, since there seem to be extensive problems on a continuing basis in that area.

Until recently, most of the Department's efforts have related to surveys, evaluations, and control, with limited effort in relation to implementing insect and disease considerations into land management plans. However, a remarkable turnaround has been made in the past 2 years. The Department now has a positive program with its State land management field units, in which the Department actively reviews and is involved in all facets of timber sale planning and reforestation efforts. In addition, the Department has implemented a very strong Service Forestry Program for the express purpose of assisting small woodland owners in getting their land under proper management to increase the fiber supply in the future. By close coordination with service forestry personnel, they are including an active evaluation of insect and disease problems and recommendations if needed in all of the Management Planning activities on these lands. The next large area of concern, of course, is the large acreage of industrial forest land, and here the Department provides technical assistance as required. It does, of course, conduct an annual aerial reconnaissance survey for insect problems, in conjunction with the Forest Service, each year. Maps of these findings are prepared and these maps are given to the landowners and, where requested, followup technical advice is provided.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Tally L.
Whitefish
Columbia Falls
Ashley L.
Little Bitterroot L.
FLATHEAD NATIONAL FOREST
TALLY LAKE RANGER DISTRICT
Ranger district boundary
1966
0 1 2 3 4 5 miles
MPB HIGH-HAZARD LPP STANDS

FIGURE 1

WORKSHOP: DIRECT CONTROL OF BARK BEETLES: A WORKSHOP TO DETERMINE THE NEED, INTEREST, AND COMMITMENT TO A COMPILATION OF THE EVIDENCE FOR AND AGAINST THE ISSUE

Moderator: Richard H. Smith

The moderator introduced the topic as follows: "In recent years there has been an ongoing controversy (of varying intensities) about the methods, merits, usefulness, and appropriateness in time and place of the direct control of bark beetles without any concerted and cooperative effort to resolve the issue, or at least to make a deliberate study of the evidence. By direct control I mean reducing the population by such measures as fell-peel-burn, fell and spray, trap tree, logging infested trees, trapout with pheromone, even augmentation of parasites and predators, etc., that is, killing beetles or removing them from the area. Direct control was actually the larger issue involved in the "Lindane Controversy" of the California Forest Pest Control Action Council a few years ago. And that issue was left unresolved.

The purpose of this workshop is to see if there is sufficient need, interest, and commitment to address this problem in a deliberate and reasonably thorough and comprehensive manner to be suitable for a published compilation. A General Technical Report by one of the U. S. Forest Service Experiment Stations is one possibility; it was the vehicle used for the "Lindane Controversy." If such interest is lacking, the program will be aborted. However, if there is a good show of interest and commitment, the workshop will then work on a format and resolve the matter of assignments, procedures for handling manuscripts, reviews, and rebuttals, and a time schedule for them. One possible schedule would be to have a manuscript review workshop at the 1980 Conference with publication prior to 1981. This is an ambitious undertaking for the work conference and its members but it would seem to be an appropriate one. I don't recall a program of this type in the past.

The beetles which could be considered are: mountain pine beetle, western pine beetle, spruce beetle, Douglas-fir beetle, Ips engraver, fir engraver.

Four points should be made in closing these introductory remarks: 1) It will be a lot of work but I am sure it will be more than equally worthwhile. 2) I would hope that the authors would draw on every possible source to support their position. 3) We do not want to get into a comparison of direct control with indirect control, the latter being the prevention of population build-up through stand management. 4) And finally, the compilation will let us see more clearly where we are--the times, conditions, places, and procedures for the use or non-use of direct control--and where we should go in research and development."

The discussion which followed the introduction continually drifted from the question (of the need for a compilation of evidence) to the usual debate on the merits of direct control. When the discussion could be interpreted as addressing the question, usually in an indirect way, the message seemed to be that there was not much of a need for such a published review, or that it would not serve a worthwhile purpose. As best interpreted by the moderator, there was no strong support individually or collectively for the program. Therefore near the end of the workshop period, the moderator decided not to proceed with the compilation of the evidence for and against direct control of bark beetles. Unfortunately post-workshop discussions with individuals revealed the presence of a silent majority in the room who felt that the program should proceed; but this majority did not express its viewpoint as clearly and frequently as the minority who opposed the program.

Prior to the workshop the following expressed a willingness to participate in the review for the respective beetles: G. C. Trostle and S. Whitney, mountain pine beetle; S. Schmid and D. Cahill, spruce beetle; L. McMullen, Douglas-fir beetle; L. Kline, pine engravers; G. Ferrell, fir engraver; R. Smith and B. Roettgering, western pine beetle.

The workshop was well attended. All seats were filled and 10-15 persons were standing.

WORKSHOP: EFFICACY OF TRAP TREES IN BARK BEETLE CONTROL
Moderator: Dave McComb

USE OF TRAP TREES FOR SPRUCE BEETLES IN THE ROCKY MOUNTAINS

Donn B. Cahill

ABSTRACT

The trap tree method for preventing and controlling bark beetles was first reported in 1864 in eastern Europe. Trap tree experiments were first conducted in the United States in the Black Hills of South Dakota in 1902. Since these early experiments, all the western Dendroctonus beetles have been under some type of evaluation to determine if populations can be trapped into host trees and chemical treated or removed before the next beetle flight.

Trapping of the spruce beetle has been the most successful over the years. New methods using a combination of pheromone and lethal chemicals are still under investigation.

One of the oldest methods for preventing and controlling bark beetles is the use of trap trees. As early as 1864 in eastern France and Germany, trap trees were used in timber stands damaged by storms. This damaged timber created disastrous outbreaks of Ips. By 1875, the outbreak was brought under control when a billion board feet had been debarked and 300,000 trees were felled to trap beetles emerging from infested trees that had been overlooked during control operations.

In 1899, A. D. Hopkins(1) made the following suggestion regarding the use of trap trees in the United States:

"I would also suggest the importance of conducting experiments with girdled and felled trap trees in some of the forest reserves threatened by bark beetles, to determine their value in preventing and controlling the ravages of destructive bark beetles."

The first trap tree experiments in the United States were conducted in the Black Hills of South Dakota during the summer of 1902(2). The host was ponderosa pine and the insect was the

mountain pine beetle (called the Black Hills Beetle at that time). The trap tree experiments were conducted by J. L. Webb utilizing A. D. Hopkins' method in which trees were felled, hack-girdled to the heartwood, belt-girdled and hacked and peeled. The result of this experiment showed conclusively that no method of preparing the trap tree was of sufficient value in controlling this insect. While many of trap trees were attacked, the percentage and density of the infestation was no greater than in adjacent healthy trees.

Blackman in 1931(2) agreed with Hopkins' results of using ponderosa pine trap trees for control of epidemic populations. Blackman mentioned the method might be useful in reducing light infestations if trap trees were used for lumber and slabs burned.

During spruce beetle outbreaks in western Colorado from 1939 through 1956, more than 5 billion board feet of Engelmann spruce were killed(4). A spruce beetle control project was conducted during 1950-1952 in which 1,209,000 infested trees were treated with insecticides. The first study to evaluate trap trees for controlling the spruce beetle was started in 1949. In 1949, Massey and Wygant(5) observed bark beetles attacking the side and bottom of sawlogs, the shaded portions and the entire bark surface of logs lying in continuous shade.

Nagel, McComb and Knight(4) in studies conducted in 1951-1955, found that: (1) spruce traps felled during the fall were more heavily infested than traps felled in the spring; (2) shady bark was preferred; therefore, traps dropped in well-shaded localities will be most effective and (3) competition from Ips beetles was minor except in the traps exposed to full sun. In general, one trap tree will absorb as many beetles as ten comparable-size standing spruce. For many years this information was used as a guideline in Region 2 for marking small sales to remove beetle populations during programmed sales.

Large timber sales were designed with trap tree areas. Trap trees were prepared the fall previous to logging and removed during the following fall and winter of the sale. This method was used to remove the spruce beetle population present at the end of a sale.

This technique worked fairly well under favorable market conditions and with reliable operators. Unfortunately, there were a number of times when the logs were not removed before beetle emergence and this created epidemic centers. Use of trap trees, if needed, is now confined primarily to small sales following a normal sale. The present utilization standards and the cleanup of logging areas after harvest have decreased the need for trap tree areas associated with spruce sales.

Lister, Frye, Buffam, et. al.(12) found that spruce trees treated with half-strength cacodylic acid received more attacks and also had lower arsenic concentrations in the phloem and cones. Application of the chemical to axe frills in late August was made with a plastic squeeze bottle. Treated trees were felled one month later and was preferable to earlier or later injections and felling time.

Trapping may be a useful tool for controlling Dendtroctonus beetles in some situations and be more important in the future with increased restrictions on use of pesticides.

LITERATURE CITED

1. Hopkins, A. D. 1899. Insects of Forests in the Northwest. USDA Forest Service Bulletin No. 21, 27 pp.

2. Blackman, M. W. 1931. The Black Hills Beetle. The New York State College of Forestry, Syracuse University, Technical Publication No. 36, 97 pp.

3. Miller, J. M. and F. P. Keen. Biology and Control of Western Pine Beetle. USDA Forest Service, Misc. Publication No. 800, 381 pp.

4. Nagel, R. H., David McComb and F. B. Knight. 1957. Trap Tree Method of Controlling the Engelmann Spruce in Colorado. Journal of Forestry, Vol. 55, No. 12: 894-898.

5. Massey, C. L. and N. D. Wygant. 1954. Biology and Control of the Engelmann Spruce Beetle in Colorado. USDA Circular No. 944.

6. McMullen, L. H. and M. D. Atkins. 1962. The Canadian Entomologist 94: 1309-1325.

7. Chansler, J. F., and D. A. Pierce. 1966. Bark Beetle Mortality in Trees Injected with Cacodylic Acid (Herbicide), ibid. J. Econ. Entomology, 59: 1357-1359.

8. Buffam, P. E. 1971. Spruce Beetle Suppression in Trap Trees Treated with Cacodylic Acid. J. of econ. Entomology 64: 958-960.

9. Buffam, P. E. and H. W. Flake. 1971. Roundheaded Pine Beetle Mortality in Cacodylic Acid-Treated Trees. J. of Econ. Entomology 64: 969-970.

10. Chansler, J. F., D. B. Cahill and R. E. Stevens. 1970. Cacodylic Acid Field Tested for Control of Mountain Pine Beetle in Ponderosa Pine. USDA Forest Service Research Note RM-161, 3 p.

11. Buffam, P. E., et. al. 1973. Fall Cacodylic Acid Treatment to Produce Lethal Trap for Spruce Beetles. Environ. Ent. 2: 259-262.

12. Lister, C. K., et. al. 1976. Refinement of the Lethal Trap Tree Method for Spruce Beetle Control. Journal of Economic Entomology 69: 415-418.

13. Knopf, J. A. E. and G. P. Pitman. 1972. Aggregation Pheromone for Manipulation of the Douglas-fir Beetle. J. of Econ. Entomology 65: 723-726.

14. Ringold, G. B., P. J. Gravelle, D. Miller, M. M. Furniss, and M. D. McGregor. Characteristics of Douglas-fir Beetle Infestations in Northern Idaho Resulting from Treatment of Douglure. USDA Forest Service Res. Note INT-189, 10 pp.

WORKSHOP: EFFICACY OF TRAP TREES IN BARK BEETLE CONTROL
Moderator: Dave McComb

TOXIC TRAP TREES REDUCE POPULATION OF WESTERN PINE BEETLE (DENDROCTONUS BREVICOMIS LEC.) IN CALIFORNIA

Richard H. Smith

Large numbers of the beetles were attracted to and killed by pheromone-baited ponderosa pine which had been sprayed with 0.4% or 1.0% lindane emulsion or 0.6% Sevin suspension. The pheromone was the triplet of exo-brevicomin, frontalin, and myrcene. The mean seasonal catch of beetles for all test trees was 234 beetles per ft^2 of sprayed bark surface with a range for individual trees of 55 to 766. The ratio of catch of the beetle to its two principal predators, Temnochila chlorida and Enoclerus Tencontei was 122 to 1 and 145 to 1 respectively, and was 51 to 1 for all other insect specimens. Some of the trap trees survived for the season. The trees most effective in killing beetles were those which remained alive the longest. More beetles were killed by lindane-treated trees than by comparable Sevin-treated trees. Unsprayed, unbaited trees adjacent to the test trees were also attacked; some of these trees survived when a post-attack spray of 1% lindane or 2% Sevin was applied within 2 weeks after the attack on them had started.

WORKSHOP: EFFICACY OF TRAP TREES IN BARK BEETLE CONTROL
Moderator: Dave McComb

IMPROVING TRAP TREES WITH PHEROMONES AND PESTICIDES

Les Safranyik

Trap-trees (i.e. freshly-felled uninfested trees) have long been recommended and used for control of bark beetles in British Columbia. Although subject to a certain amount of controversy regarding their efficiency, their use has "apparently" been successful, at least in conjunction with other control procedures, at times. We feel that under certain conditions, such as cleanup following sanitation logging or where populations are still low, such methods of direct control can be useful tools. As part of a technology development and demonstration program, we have carried out experiments using pheromones and pesticides with Douglas-fir beetle in an attempt to improve the efficiency of trap trees in removing beetles from the population.

A. Use of pesticide on pheromone-baited trap logs

At each of two locations, 16 logs (8 from each of 2 trees), 1.2 m (4 ft) long, were placed about 3 m apart in a 4x4 design. The logs were placed on supports and an 80 x 122 cm tray was placed under each log with the tray width along the longitudinal axis of the log. Three chemical treatments (Lindane (1%), Dursban (2%), and Reldan (2%)) and a check were assigned to the logs in a Latin Square design. The sprays, formulated from emulsifiable concentrates in water, were applied with a hand tank pump to drip point.

The trees were felled and logs put in place and sprayed on 27 April. The trays were put in place and a polyethylene cap dispenser with 0.5 ml frontalin was attached to each log the following day.

Dead beetles were collected from the trays at weekly intervals until 22 July. The beetles were counted and stored in 70% ethanol until sexed later. The parent galleries in each log were counted and measured on 26 and 27 July.

Over 23,000 beetles were taken in the trays. The data were converted to numbers per 0.1 sq m of bark surface (Table 1). Analysis indicated that Reldan and Lindane were better than Dursban and all three chemicals better than the check for the four

variables (beetles killed, females killed, number of galleries, and gallery length) examined.

Table 1. Numbers of four variables per 0.1 sq m of bark surface on chemically treated logs, Douglas-fir beetle, Kamloops, 1977

Treatment	Beetles killed	Females killed	Galleries	Gallery Length (cm)
Lindane (1%)	101.9	38.6	0.42	3.1
Dursban (2%)	68.3	26.4	0.76	7.7
Reldan (2%)	118.9	52.4	0.30	3.4
Check	7.8	1.6	6.54	82.7

Although interpretation of these differences is dependent, at least in part, upon response to the chemicals both before and after contact, some conclusions can be drawn. If one assumes that two beetles, one of which is a female, is involved in each gallery, then the data indicates that up to 6.5 fold as many beetles were removed from the population with the chemicals as in the check (Table 2). This impact is probably conservative since more beetles were found dead in the check trays (6.5 per 0.1 sq m) than one might normally expect.

Table 2. Estimate of number of beetles removed from population by chemically-treated and untreated trap logs.

Treatment	Beetles per 0.1 sq m[1/]	Females per 0.1 sq m[2/]	As percent of check beetles	As percent of check females
Lindane (1%)	102.7	39.0	492	481
Dursban (2%)	69.8	27.1	335	335
Reldan (2%)	119.5	52.7	573	651
Check	20.9	8.1	---	---

1/ Number of beetles killed + 2 X number of galleries
2/ Number of females killed + number of galleries

In 1978 a similar experiment, without the check, compared Lindane (1%), Reldan (2%), and Sevin (2%). The Sevin spray was formulated from Sevimol 4. Over 24,000 beetles were taken but no significant differences among the three chemicals in numbers of beetles killed, gallery numbers, or gallery lengths could be detected.

Although the chemicals were effective in reducing the numbers of successful galleries, brood success was not eliminated. Thus in remote areas where destruction of attacked logs (i.e., cleanup of trap trees) is not feasible or is expensive, treatment with cacodyllic acid or MSMA before felling may be an additional useful technique in combination with pesticide and pheromone techniques.

B. Use of pheromone on pesticide-treated trap trees

When pesticides are used on host material, the pesticide could interfere with the behavior of the insect and its production of natural pheromone. To demonstrate whether pheromones were necessary and whether we needed the full pheromone complex with Douglas-fir beetle, two experiments were conducted, one with 4-ft (1.2-m) logs and one with standing uninfested trees.

Each experiment was carried out at two locations at least 1.6 km apart. Each experimental unit (i.e. tree or log) was at least 20 m distant from any other. Lindane (1% prepared from emulsifiable concentrate in water) was sprayed to drip point over the surface of the logs and the lower 4m (12 ft) of the bole of the trees. A tray, as used in the pesticide study, placed under each log and a basket attached to the base of each tree, was used to collect dead beetles.

Four treatments were assigned in a randomized complete block design with three blocks at each location. Treatments consisted of frontalin, seudenol, frontalin and seudenol, and a check. The pheromones were dispensed from polyethylene caps attached to the most shaded side of the trees (at breast height) or logs. The experiments were established in mid-April before beetle flight and dead beetles were collected weekly from the baskets and trays from the first week in May until mid-July. Enough of the beetles from every other week's collections were sexed to provide an estimate ($\pm$ 5%, P = .95) of the proportion of the sexes. Many Clerids were also collected and counted.

Table 3. Numbers of Douglas-fir beetles and Clerids taken at Lindane-sprayed trees and logs with different pheromones, Kamloops, 1978.

Experimental host	Insect species	Pheromone treatment			
		Frontalin	Seudenol	Frontalin & Seudenol	Check
Trees	D. pseudotsugae	27308a[1/]	8262	34401a	1579
	T. undatulus	1193a	1272a	1937a	119
	E. sphegeus	221a	109	239a	37
Logs	D. pseudotsugae	7006a	1222	9167a	49
	T. undatulus	687a	731a	1285	6
	E. sphegeus[2/]	3	0	3	0

1/ Numbers in rows followed by the same letter not significantly different (P = .05).

2/ Not analyzed.

The results (Table 3) indicated no significant differences in the numbers of Douglas-fir beetle attracted to logs or trees between the frontalin alone and the frontalin and seudenol together, but both these treatments attracted more beetles than seudenol alone. The proportion of females among the beetles was about 28% for the seudenol treatment and 20% where frontalin was included in the treatment.

Some of the check trees were attacked and beetles were taken at the attacked trees. Of interest here was that the beetles taken at the attacked check trees were taken only during a short period of the season.

Thanasimus undatulus was taken in considerable numbers at both trees and logs whereas Enoclerus sphegeus was taken only at trees. No significant differences in numbers of Thanasimus was evident among the pheromone treatments at trees, but significantly more were taken at the frontalin and seudenol treated logs than at those logs with either frontalin or seudenol alone. The numbers of Enoclerus taken were significantly less at seudenol-treated trees than at those trees with frontalin included in the pheromone bait.

C. Conclusions

1. Where the host of Douglas-fir beetle is used as a trap tree, the relative efficiency of the trap in removing beetles from the population can be greatly increased (up to 6 or 7 fold) by the use of pesticides pheromone-baited trap trees.

2. Although the pheromone complex of Douglas-fir beetle includes both frontalin and seudenol, only frontalin is necessary when used with the host material.

3. Uninfested standing trees as well as felled trees can be used as trap trees.

4. Sevin spray, prepared from Sevimol 4 concentrate in water, is an effective pesticide for this purpose.

Control of Outbreak Populations of Secondary Bark Beetles by Trap-tree Method

J. A. Rudinsky

The trap-tree method - or the natural pheromone attraction method, as we know it now - has been used in Europe for control of Ips typographus population in outbreak situations for several centuries. Outbreak populations of this most important European bark beetle have developed periodically after strong windstorms, heavy snow or ice damage, fire, drought, etc. The increased population developed in this material subsequently kills living spruce trees. Because even in outbreak populations this beetle prefers to invade fresh down trees (as long as they are available in the stand), European foresters provided such material along roads to absorb or trap the high population into these logs, which were then removed from the forest before the new generation of beetles emerged in the next April.

Several of our secondary bark beetles of the genus Ips and at least two species of Dendroctonus (pseudotsugae and rufipennis) in the Western United States and Canada exhibit similar preference and attack behavior during increased population level. There is no doubt that in the future during more intensive management of our forest and a more developed road system, a similar approach to control outbreaks of the mentioned species will be attempted. In fact, some research along these lines is already taking place (as reported in this panel).

An actual successful trap-tree program during an epidemic of Ips typographus in a small forest district comprising some 15,000 acres in Central Slovakia is described briefly here (P. Svihra, Les, 1974). I. typographus is a polygamous species (usually 3-4 females with one male), with one generation and several sister broods per year; it is estimated that 2/3 of the females from spring attack emerge and participate in the second attack. The trap trees are cut along the edge of the stands with crown lying inside the stand in north-south direction. They are debranched and the trunks are covered with cut-off branches.

There are three series of trap trees cut during the flights of the beetle, and the number of trap trees cut in each series depends on the number and intensity of invasion of the preceding series or (for the trees cut for 1st series) the number of trees invaded the preceding year.

The first series of trap trees had a total of 380 trees, cut by the end of March; this number was arrived at from the following factors:

1. There were 400 trap trees invaded the preceding year and removed before March; for each 5 trees removed, they cut 1 new trap tree, i.e. . . . . 80 trees
2. There were 100 standing infested trees last year; for 1 standing infested tree, they cut 1 new trap tree, i.e. . . . . 100 trees
3. 100 trap trees were not removed on time by the end of March; for each trap tree not removed, they cut 2 new trap trees, i.e. . . . . 200 trees

Total for first series 380 trees

The second series of trap trees was supposed to absorb mostly the reemerged or sister brood beetles. These trap trees had to be cut 2-3 weeks after the trap trees of the first series were invaded. The number of trap trees of this second series was computed from the number and intensity of invasion of the first series of 380 trap trees, as follows:

1. 340 trees were heavily invaded; for each 3 heavily infested trees, they cut 2 new trap trees, i.e. . . . . 226 trees
2. 40 trees were lightly infested; for each 5 lightly infested trees, they cut 1 new tree, i.e. . 8 trees

Total for the second series 234 trees

The third series was supposed to absorb the beetles in the "summer flight". The trap trees of this series should be cut some 5-6 weeks after the main or spring flight occured, and the number of trees to be cut was computed from the number and intensity of invasion of the first series plus the number of standing trees invaded during spring flight, as follows:

1. 340 trees were heavily infested; for each 2 trees heavily infested, they cut 1 new trap tree, i.e. . 170 trees
2. 40 trees were lightly infested; for each 10 trees lightly infested, they cut 1 new trap tree, i.e. . 4 trees
3. 40 standing trees were invaded during spring flight; for each 2 trees invaded they cut 1 tree, i.e. . . . . 20 trees

Total for third series 194 trees

WORKSHOP: INSECT IDENTIFICATION NEEDS AND OPPORTUNITIES
Moderators: Malcolm M. Furniss and David Cibrian Tovar

"Correct identification of the pest species is the first step in scientific pest control". National Acad. Sci. Publ. 1695 (1969, CH. 2).

This workshop resulted from a session held in March, 1978, at Durango, Colorado (see Proceedings 29th WFIWC, pages 83-85). The workshop was highlighted by the presence of Lloyd Knutson, Chairman, Insect Identification and Beneficial Insect Introduction Institute, USDA, Beltsville, Maryland 20705. He showed slides of the facilities and personnel of the Institute's Systematic Entomology Laboratory (SEL) including a vintage photo of an early day worker (Theo. Pergande) on the edge of his chair peering through a monocular microscope. Todays workers were seen to be no less engrossed in their work. SEL identifies about one-third million specimens annually, retaining about 50,000 specimens for deposit in the U. S. National Museum of Natural History, which itself houses about 24-1/2 million specimens (for an historical account of the Museum's history, including the relationship of SEL and USNM see Sabrosky (ESA Bull. 10:211-220).

SEL staffs 29 systematists but still falls short by at least four scientists of the capability to identify several important groups. Presently they are unable to accept Tortricoidea, Gelechioidea, Orthoptera, Thysanoptera, Isoptera, and others. Due to the heavy identification load, parasitic Hymenoptera are not accepted without having their host insects known, unless special circumstances are explained. The situation with regard to Trichogrammatidae has been eased by hiring of Carl Goodpasture by the Beneficial Insect Introduction Laboratory. Problems in identifying Tachinidae and weevils are anticipated in the near future. SEL will lose Curtis Sabrosky (Tachinidae) via retirement next year. Recruiting of an Orthopterist-Isopterist is underway. Request has been made in the 1980 budget for a Hymenopterist but chances are questionable.

Lloyd provided a handout containing titles of SEL Staff and their research projects that involve forest insects, suggestions for cooperative biosystematic research between them and forest entomologists, including preferred locations (list available from the moderator or Dr. Knutson). Following the meeting Dr. Douglas Ferguson, a specialist in Geometroidea, expressed interest in coming to Idaho to study geometrids of forest shrubs, with which one of the moderators is concerned.

Problems encountered in identifying forest insect specimens received at the Museum can be prevented by careful mounting, full labeling, grouping specimens into families and careful packaging

for shipment. Published instructions for submitting insects appeared in Bull. ESA 22:130;17:6-8. The best general reference on collecting and preserving insects is probably USDA Misc. Publ. 601.

Lloyd reported that new catalogs of North America Hymenoptera and Coleoptera, and World Diptera are in the works. Data for the catalogs is being computerized to facilitate updating and searching. The Coleoptera catalog will cover some 24,000 species in the US and Canada. The first of 119 family fascicles (Heteroceridae) was published in 1978. Others will follow on an indefinite schedule and will include fasicle 76 Cleridae by William F. Barr, University of Idaho; and Platypodidae by Stephen L. Wood, BYU, who participated in the workshop. The Hymenoptera catalog will be published in two volumes in 1979; the host index will follow in 1980. The Diptera catalog is farther away from publication.

Lloyd announced that a 10-day short course on identification of parasitic Hymenoptera is scheduled for summer 1980 at the University of Maryland and that a similar course might be scheduled in the West, depending on interest (contact Paul M. Marsh).

Mexico

Professor David Cibrian, National Agricultural School, Chapingo, reviewed the situation in Mexico. The largest collection (300,000 specimens) and staff of taxonomists (14) is at the University of Mexico in Mexico City. Other collections are located at the National Agricultural Research Institute (70,000 specimens); Natural History Museum (30,000 specimens); and National School of Biological Sciences (15,000). Four collections are located in Chapingo on the campus of the National Agricultural School. One of these, consisting of forest insects, is located in the Forestry Department and is maintained under the direction of D. Cibrian.

David noted that many Mexican insects reside in collections outside his country and that donation of representative specimens would be greatly appreciated. David is interested in having Mexican forest entomologists become trained in taxonomy. Arrangement is possible for foreign specialists to receive financial support to study Mexican insects. He also wishes to send his students abroad for training under the personal supervision of specialists in selected taxa.

Canada

Regretably, Donald Bright was unable to attend from the Canadian Biosystematic Research Institute (BRI). However, J.E.H. Martin

sent a letter which was read. The BRI is surveying arthropods of Canadian Parks and plans to computerize data gathered. They are issuing a series of handbooks on the insects and arachnids of Canada. Part II was published in 1976 on the Bark Beetles of Canada and Alaska by D.E. Bright, Jr.

Museum specimens are loaned by BRI worldwide to reputable workers and visits are encouraged to study specimens in the Canadian National collection. Identification service is free. In 1978 20,000 specimens were identified for persons in the U.S.; 2,500 were kept. A list of specialists and annual publications is available from BRI, Ottawa, K1A 0C6.

Mites and Nematodes

John Moser, Forest Service, Pineville, LA 71360, provided a copy of his Research Note SO-214, Key to Mites Commonly Associated With the Southern Pine Beetle. Availability of similar keys for insect groups would greatly assist entomologists in the field. John expects that Donald Kinn will be set up to identify nematodes of forest insects in the near future (William R. Nickle, Nematology Lab, Beltsville, Maryland 20705 also identifies nematodes of insects.)

Written Suggestions Received

Robert L. Furniss, Portland, Oregon, author of "Western Forest Insects" was unable to attend but forwarded the following comments:

1. Several insect groups need definitive taxonomic study; perhaps Neodiprion most of all.

2. Forest Service Regions and others should preserve and designate voucher specimens to substantiate survey observations and reports. Lack of substantiation of species involved was a problem encountered during preparation of USDA Misc. Publ. 1339.

3. Cooperative studies between biologists and taxonomists are needed to solve taxonomic problems encountered in the field. (Echoed by the moderators and Stephen L. Wood, BYU, Provo, Utah)

4. An annotated directory is needed on who's who and where in insect taxonomy. The directory should be updated periodically and should list costs or limitations imposed on identifications.

Other written suggestions for discussion were received from H. R. (Dick) Wong, Canadian Forestry Service, Edmonton; Stephen L. Wood, BYU, Provo, and Torolf Torgerson, Forest Service, Corvallis.

A list of topics was then developed by workshop participants and discussed as far as time permitted. The following recommendations were made:

1. Implement cooperative biosystematic studies at western locations of insects of mutual concern to field personnel and SEL taxonomists.

2. Publish and maintain an up-to-date directory of taxonomic specialists and insect groups that they will identify. (The Association of Systematics Collections is developing a list of persons in U.S. and Canada by insect order. ESA is in the process of developing a directory of members and their interests, including taxonomic specialists. Meanwhile lists are available from SEL and BRI regarding their staffs.)

3. Increase base funding of SEL to enable revision and identification of forest insect groups for which there are insufficient specialists.

4. Emphasize to the public and to administrators the importance of insect identification (taxonomy) in the management of economically important insects and in research on insects of all kinds.

5. Define the importance of taxonomic services in the position descriptions of federal systematists as a significant factor in their advancement and promotion. "Taxonomic services" involve identification, information on hosts, distribution (including habitat) and much other information of scientific importance.

6. Identify taxonomy as a legitimate function in Forest Service position descriptions where appropriate for the person and assignment.

7. Develop identification aids for immature and adult stages including well illustrated keys for field personnel and technicians.

8. Revise important insect groups including Neodiprion, Choristoneura, Magdalis, Pissodes, Cylindrocopturus (reference to Misc. Publ. 1339 will uncover others).

9. Encourage insect faunal studies in Western North America to develop a fuller knowledge of species of damaging and beneficial insects and their hosts and distributions.

10. Develop a catalog describing western forest insect collections, including persons to contact about them and the taxa and numbers of specimens represented. This is particularly

needed for relatively little known collections such as some at Forest Service field locations.

11. Increase the utility of the U.S. Hopkins card system by adapting it to computer storage and retrieval.

12. Designate and deposit in USNM, BRI or other collections, voucher speciments related to studies, surveys and introductions of foreign parasites (see Bull. ES Canada 10:42 and terminal bibliography).

13. Provide regional short courses on insect identification.

The moderators would appreciate receiving comments and suggestions on the subject of insect identification including problems that are encountered.

WORKSHOP: INTERNATIONAL OPPORTUNITIES IN FOREST ENTOMOLOGY
Moderator: Robert I. Gara

Most of the participants discussed forest entomological opportunities in Latin America. Exceptions were short presentations by Ron Stark and Alan Berryman. Ron felt that permanent opportunities in Europe were virtually nonexistant. However, there are various grants and fellowships available for short term studies. Alan discussed forest entomological research in Italy and Greece; he also mentioned that European fellowships are available for travel and research opportunities.

Opportunities in Mexico were discussed by David Cibrian. He welcomed the opportunity to closely cooperate with U. S. and Canadian entomologists who may wish to work in Mexico. He described the educational and research programs currently under way at the National University.

The forest entomological program in Chile was presented by Osvaldo Ramirez. The Chilean forest service (CONAF) recently created a forest protection division that consisted of a head (Ramirez) and an educational coordinator. The job of the coordinator is to conduct regularly scheduled short courses in forest protection. These courses would be attended by CONAF personnel as well as private industry foresters. Besides these tasks, the coordinator would assist Ramirez in organizing emergency survey and control projects as well as in the preparation of program analyses, work plans, and routine reports. The task of overseeing forest protection activities at the region level (Chile is divided into 12 regions) would be undertaken by regional, forest protection supervisors.

Basic and applied research activities would be contracted with the Chilean universities. There are many research opportunities for non-Chilean ; cooperation would be welcomed.

Case histories for forest entomological activities in Latin America were presented by Ron Billings and Ed Holsten; their reports follow:

Forest Entomology in Costa Rica

by Edward Holsten
U. S. Forest Service

I would like to begin this discussion with a short introduction concerning tropical forest entomology in general. I am limiting this talk to Costa Rica, specifically the mixed hardwood forests. Emphasis will be placed on one forest pest, the Mahogany Shootborer, Hypsipyla grandella (Zeller) (Lepidoptera: Pyralidae). However, many of the aspects and situations which concern this insect pest will apply to other tropical forest pests as well.

First, let us take a look at a few characteristics pertaining to tropical forests:

1. They are mixed forests in the natural state comprising hundreds of species per hectare.

2. Many of the species are quite site specific. Little is known concerning their silviculture.

3. When plantations are involved, they are usually located on the poorer sites. The unnatural occurrence of forest monocultures in the tropics plus the poor vigor of these trees on poor sites has resulted in increased insect activity.

Second, generally what do we know concerning tropical insects:

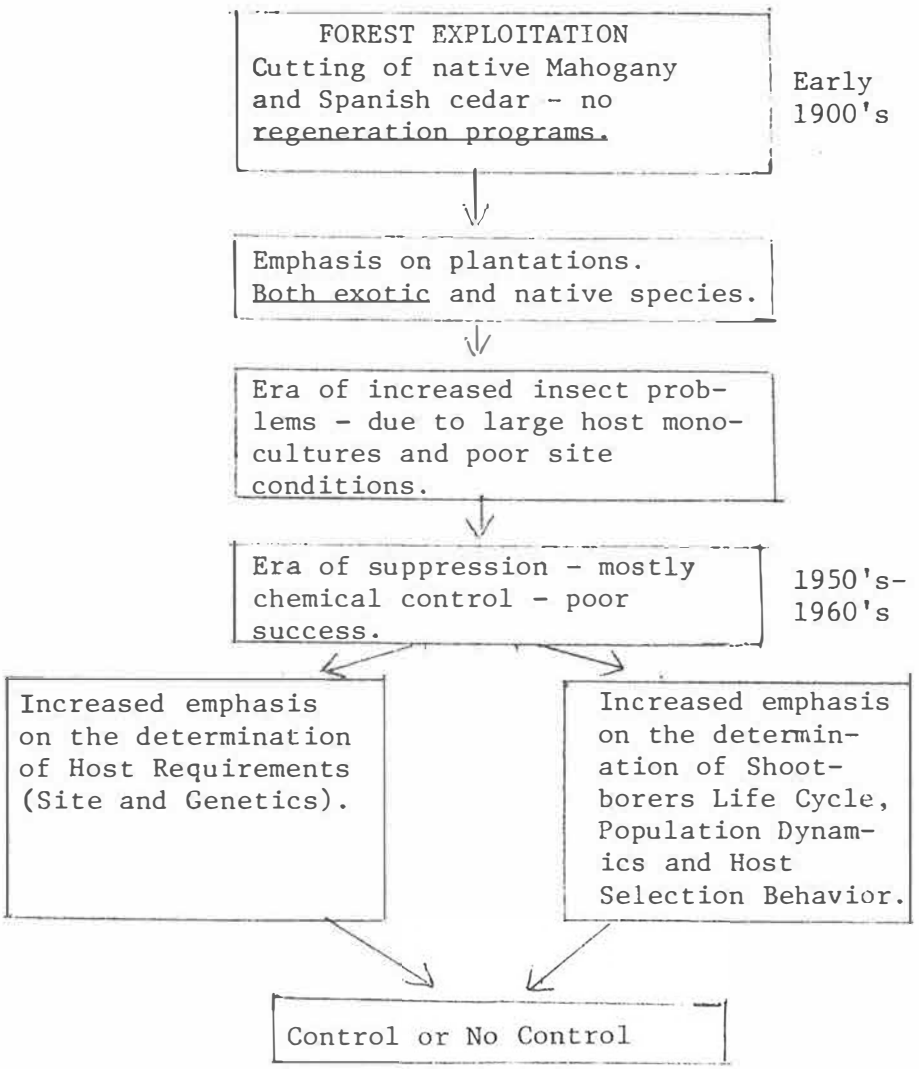
1. Many, many species. Tropical species have very specialized stereotyped behavior(s). This is a result of the high degree of competition between so many species. Such behaviors are difficult to unravel. However, once they're known, the insect's behavior is easily predictable.

2. Although there are many species, population levels of a given species are quite low when compared to their temperate zone counterparts. This, at times, provides a problem to the researcher. Statistically sound data is hard to obtain when populations are low. For example, in two years of field

testing of natural and synthetic shootborer pheromones, I was only able to trap approximately 100 males.

3. However, tropical insects usually have many generations per year. In many respects this helps off-set the problem of low numbers. The shootborer has eleven or more generations per year!

Let us now briefly look at the development of forest entomology in Costa Rica using the Mahogany Shootborer as the pest species. This can be best done graphically:


FOREST EXPLOITATION
Cutting of native Mahogany and Spanish cedar - no regeneration programs.
Early 1900's
Emphasis on plantations. Both exotic and native species.
Era of increased insect problems - due to large host monocultures and poor site conditions.
Era of suppression - mostly chemical control - poor success.
1950's-1960's
Increased emphasis on the determination of Host Requirements (Site and Genetics).
Increased emphasis on the determination of Shootborers Life Cycle, Population Dynamics and Host Selection Behavior.
Control or No Control

As we can see from this flow chart, shootborer research is now dealing with the insect and its very specialized behavior as well as determining the specific site requirements of the host. We now know that in many cases the shootborer is a secondary pest - the primary problem has been low host vigor - a direct result of poor site conditions.

Now I'd like to show you a few slides depicting what we have just discussed. These slides will also illustrate different tropical forest conditions and their associated insect pests. (Slide Presentation).

I would like to conclude this discussion with a general outline of research possibilities and problems in Costa Rica:

1. In Costa Rica there is no agency in charge of forest entomology. What research is being carried out is undertaken either through the Organization for Tropical Studies (O.T.S.-San Jose) or at the Centro Agronomica Tropical de Investigacion y Ensenaza (C.A.T.I.E.) located in Turrialba, Costa Rica.

2. There are no regular forest entomology courses offered in Costa Rica. Occasionally a graduate course is given at the Forestry School - C.A.T.I.E.

3. Many opportunities exist for forest entomology research. Even though my discussion has centered around one tropical hardwood pest, emphasis is now being given in Costa Rica to pine monocultures. It is too soon to say if there will be any insect problems associated with these plantations but if past experience has anything to offer, there <u>will be</u> problems. These pure pine plantations are being placed on very poor sites.

4. If you're fully funded, you'll have few problems concerning your research. However, don't expect host nationals to provide much funding. This is due to:

A. Lack of money.

B. Different priorities (agriculture, health, education, etc.).

C. Likewise, there has been an increase in highly competent Latin and Central American scientists and a corresponding increase in local awareness of their own scientific abilities.

1.) Good case in point is Brazil.

5. Above all, for those of you who will pursue tropical forest entomology - avoid Scientific Imperialism. Involve host nationals as much as possible in your projects. You will receive much more cooperation by doing so. Likewise, such involvement helps ensure the continuation of your project after you leave.

Potential for Forest Entomology in Latin America

by: Ronald F. Billings
Texas Forest Service

Unlimited opportunities for studying forest insects exist throughout Latin America. Many insect species remain to be described taxonomically and the biologies of all but a few species are largely unknown. On the other hand, the present demand for work in economic forest entomology and financial support for investigating forest insect pests varies drastically from one country to the next. The need for forest entomologists is directly dependent upon the value a particular country places on its forest resources.

To illustrate this point, forest pest conditions and opportunities in forest entomology were discussed, based on my personal experiences, in relation to the forestry programs in three regions of Latin America: the Dominican Republic, Central America and Chile.

Dominican Republic - This country, which shares the island of Hispañola with Haiti, is in a state of exploitation. The native pine forests have been largely cut over and the more valuable hardwood species (mahogany, ebony) are being selectively harvested from the lowland tropical forests. Until very recently, no attention has been given to reforestation. As a result, even though native forest insects are abundant, the Dominican Republic has no economic forest pests. Protection consists of controlling wildfire and preventing the clearing of additional forests for subsistence farming. Accordingly, at this stage in the development of its forestry programs, the Dominican Republic has placed priority on reforestation, soil conservation, and fire protection; protection from insects is of no immediate concern. As forest nurseries are established and cut over lands are reforested, however, the need for forest entomological studies should gradually increase.

Central America - Guatemala, Honduras and Belize (British Honduras) are subject to sporadic and devastating outbreaks of Dendroctonus bark beetles which threaten the native pine forests. These countries periodically request entomological assistance from more developed countries (USA and Germany,

primarily) whenever severe pest problems arise. Of the three countries, only Honduras has developed a substantial forestry program. As timber production is increased through forest management practices (regeneration, thinning, prescribed burning, etc.), a greater variety of native pest problems is beginning to surface.

Chile - This South American country lies at the other extreme of the forestry spectrum. Chile has no native pine forests. To replace dwindling hardwood forests of Nothofagus, Laurelia and other native species, nearly 500,000 hectares (more than 1MM acres) of exotic conifer plantations have been established during the past 30 years. Ninety percent of the plantations consist of Monterey pine, Pinus radiata, known to be susceptible to a number of insect and disease pests.

Prior to 1967, only a dozen insects had been collected from Monterey pine in Chile. An intensive survey conducted by Peace Corps entomologists during 1968 and 1969, however, increased the list of potential pest species to 37 (Billings, et al 1972). Of these, only three species, Pineus borneri Ann. (Homoptera: Adelgidae), Buprestis novemmaculata L. (Coleoptera: Buprestidae), and Ernobius mollis L. Coleoptera: Anobiidae) are introduced pests. The remainder includes a variety of defoliating and wood boring insects that have successfully changed food preferences from native hardwoods to pine.

The extent of the exotic forest monoculture in Chile, the wide variety of sites (both suitable and unsuitable) occupied by these plantations and the large number of phytophagous insects that already have adapted to this food resource are factors that have set the stage for eventual insect outbreaks. Efforts by Peace Corps entomologists to initiate a forest protection program (Billings, et al. 1973) progressed, through the aid of FAO funding and consultants, to the establishment of a national forest pest survey and control program (PESCOP) involving Chilean foresters and entomologists. The ultimate goal of this program is to create a pest management system for exotic and native forests that will become part of Chilean forest policy (Gara 1978).

The Chilean government has recognized the importance of

forest insect investigations and an intensive forest protection program to safeguard both native and introduced tree species that make up this country's forest resource. In similar fashion, forest entomology in other countries of Latin America is bound to become increasingly important as their respective forestry programs develop.

LITERATURE CITED

Billings, R. F., E. H. Holsten, and A. Eglitis. 1972. Insects associated with Pinus radiata D. Don. in Chile. Turrialba 22: 105-109.

Billings, R. F., E. H. Holsten, and R. I. Gara. 1973. Forest entomology in Chile: an example of U. S. - Chilean Cooperation. J. For. 71: 164-5.

Gara, R. I. 1978. Forest protection in Chile. CONAF/PNUD/FAO CHI - 76/003. Unpublished FAO report. 140 pp.

WORKSHOP: POTENTIAL OF NATURAL CONTROL AGENTS FOR BARK BEETLES
Moderator: Stu Whitney.
Advocates: Fred Stephen, Mark Chatelain, John Moser, Jim Lowe and Amy Lester, Stu Whitney, Lynn Rasmussen, Don Dahlsten.
Attendees: 37 people sat in. Contact Stu Whitney for their names and their expressed interest in this Workshop.

SCOPE, ASSUMPTIONS AND PROVACATIONS

Consider only natural enemies i.e. parasites, predators, and diseases, of tree killing Dendroctonus and or Ips; Also, that - pests are unwanted organisms,
- organisms will increase if unchecked,
- most organisms are checked most of the time,
- such checking suggests the idea of control,
- man attempts control to improve his competative position,
- natural control is not likely to be spectacular, fast acting or of short duration,
- man's use or manipulation of natural control is unnatural.

SUMMARY

Parasites and Predators - Insects:

Fred Stephen described life tables of southern pine beetle in loblolly and slash pine that included a parasite and a predator of the beetle. A model simulating beetle population dynamics was used to assess the effects of removing these natural control agents. Allowing a 1:1 beetle parasite and a 2:1 beetle predator mortality, there was a marked increase in beetle population size and tree mortality after 3 months.

Approaches to biological control of the mountain pine beetle through augmentation and conservation of entomophagus insects were presented by Mark Chatelain. "Application of these methods is intended for integration with other tactics, particularly silvicultural tactics, to provide an environmentally safe and effective strategy for managing the mountain pine beetle (mpb) (Dendroctonus ponderosae Hopkins) in lodgepole pine (Pinus contorta var. latifolia Douglas) stands.

Predator conservation may be accomplished by modifying intermediate and harvest cutting practices. For example, the clerid Enoclerus sphegeus (F.) migrates to the base of mpb

the rate and degree of drying which in turn can be responsible for much MPB mortality.

From observations made during life table sampling of MPB in the last 16 years, we are not convinced that P/P hold much promise in regularing MPB populations except possibly in some individule trees. Some of these trees may have high densities of Coeloides and/or Medetera or woodpeckers may have taken a high proportion of the MPB brood and exposed the remainder to the effects of increased drying.

In a laboratory study conducted to determine some causes of MPB egg mortality a nematode, Mikoletzkya pinicola (identified by Cal Massey), was responsible for killing 4.06% (out of a total of 6.21%) of 2,093 eggs studied --- this was by far the most of any of the mortality causes identified."

Perspectives

Some perspectives comments were raised by Don Dahlsten.

"The main theme of my comments was that natural enemies of bark beetles have not really been studied in detail and more often are just overlooked as not being important. As Fred Stephen pointed out in his talk, a seemingly insignificant amount of parasitism and predation can actually be quite important. I finished by making a plea for the funding of research on natural enemies. Usually only the target bark beetle is considered when evaluating silvicultural practices to protect against losses to beetles or chemical control to kill bark beetles directly. An evaluation of bark beetle natural enemies should be a part of any indirect or direct control attempt."

infested trees to overwinter. Snakefly larvae (Agulla sp.) also concentrate near the base in late October. Results from field data suggest that high-stumping infested trees to a height of 35 cm (ca 1 ft.) and not treating these stumps with insecticides during cutting operations would conserve 11 percent of the E. sphegeus larvae and 3 percent of the snakefly larvae in each brood tree. Bark population samples showed that larvae of both species are also present in trees attacked during the previous year. Studies will be conducted to determine the feasibility of conserving a greater percentage of the predator population by high-stumping these trees.

"Pheromones may provide the means for manipulating entomophagous insects to enhance their effectiveness as a mortality factor against mpb. Field tests in lodgepole pine stands showed that adults of the predaceous clerid, Thanasimus undatulus Say, were strongly attracted to sticky traps baited with frontalin (racemic mixture). These traps were baited from mid-June to September and most T. undatulus adults were trapped from June to early-July. However, stands baited with this pheromone during the period of beetle emergence had a significantly greater amount of mpb caused tree mortality than non-baited stands. This suggests that frontalin also attracts mpb. Thus, to augment T. undatulus populations without attracting mpb, stands should be baited during the period of maximum clerid flight activity (June to early July) and the bait removed prior to beetle emergence in late-July. This hypothesis will be tested in the upcoming field season."

"The ultimate effectiveness and utility of conservation and augmentation of entomophagous insects will be evaluated on the basis of mpb survival and tree mortality."

Mites and Nematodes

"John Moser reviewed work on bark-beetle associated mites at Pineville, LA. The collection, started 15 years ago, is the largest of its type in the world, containing over 15,000 specimens on slides plus several thousand more in alcohol, and representing 377 species. Although the collection is nearly complete for mites associated with southern pine bark beetles, those of western pine bark beetles are also well represented. Past and current work was illustrated with a series of color slides illustrating the various subcortical niches utilized by the mites."

John also noted that Don Kinn, also at Pineville, is developing a research program on nematodes associated with bark beetles.

Woodpeckers

The assessment of numerical and functional responses, breeding success and mortality impact of woodpeckers in a mountain pine beetle epidemic in the North Fork of the Flathead River in Montana was introduced by Jim Lowe. Amy Lester showed slides of the 6 sorts of woodpeckers that are involved and described their various nesting and feeding habits and how they disrupt the bark-beetle habitat.

Diseases - microorganisms

The potential of microorganisms (bacteria, fungi, protozoans and viruses) to produce acute or chronic diseases or to upset essential bark-beetle symbiosis was introduced by Stu Whitney. There are several reports of bark-beetle diseases in the literature, and microbes have been successfully used against other insect pests, but there are no known recommendations for using microbes against Dentroctonus or Ips. A test with adult mountain pine beetles topically inoculated with the entomopathogenic fungus Beauveria bassiana showed that in the forest at Riske Creek, B.C., natural mortality of 6% was raised to 30%. Further experiments are underway to increase the efficacy of beetle disease production and to devise methods for self-inoculation.

Contrary

Lynn Rasmussen offered the following comments on parasites and predators affecting mountain pine beetles:

> "In two studies of the mortality causes, we have found that parasites/predators exert little influence on populations of MPB.
>
> We have found that the P/P as a group exert the least influence of any mortality risks studied. We found that the risk of a MPB dying from a P/P, especially when acting in the presence of other risks, does not offer much regulating influence upon MPB populations.
>
> In addition, we found that the effects of P/P are reduced as a result of high winter kill. However, woodpeckers, apparently responding to high beetle populations during the winter, can remove large amounts of bark from some trees, thereby, increasing

WORKSHOP: GENETICS RESEARCH IN FOREST ENTOMOLOGY

Moderator: Molly Stock
Participants: Kareen Sturgeon, Nancy Lorimer

SUMMARY

Evolutionary Interactions Between Bark Beetles and Their Host Trees -- K. Sturgeon, University of Colorado.

Population structure of Colorado mountain pine beetle (Dendroctonus ponderosae) populations was shown to be related to both geographic location and host tree. Using starch gel electrophoresis, 400 beetles were assayed for protein genetic variation at 13 loci. At 3 out of 5 polymorphic loci, mountain pine beetles emerging from ponderosa and lodgepole pines in geographically separate localities were significantly differentiated from one another. In addition, mountain pine beetles emerging from ponderosa pine were significantly different from beetles emerging from either lodgepole or limber pines in the same stand.

Population structure of ponderosa pine was shown to be affected by predation by western pine beetles, Dendroctonus brevicomis. Gas-liquid-chromatography was used to determine the monoterpene composition of xylem resin of 617 trees in 5 populations in northern California and southern Oregon where there has been a continuous history of western pine beetle infestation. Results suggest that this beetle may exert both a directional and a frequency-dependent selection pressure on chemically polymorphic populations of ponderosa pine. Trees which survived infestations are both chemically unique and they contain large quantities of limonene, a monoterpene known to be toxic to the western pine beetle. Trees which appear to be preferred by the beetle contain low proportions of limonene and large quantities of alpha-pinene which has been implicated as a precursor to the insects' population anti-aggregation pheromones, trans-verbenol and verbenone.

These results suggest that an understanding of the interactions between coevolving organisms will necessarily involve an understanding of the population structure of both the insect and its host trees.

Genetic Variability in a Forest Insect: Extent and Relevance -- N. Lorimer, North Central Forest Experiment Station.

Genetic variability in the forest tent caterpillar, Malacosoma disstria Hubner, is being investigated in order to relate population genetic structure with population outbreak and crash. Insects are reared in sib groups on prepared diet to the adult stage. Measurements include eggs/mass, hatchability, survival, sex ratio, dev-

elopment time, pupal weight, and eggs/female. These characters are significantly different among sib groups, among populations, and between sexes. A melanin polymorphism of adult males also varies in frequency, as does an electrophoretically detectable locus responsible for production of the enzyme superoxide dismutase. Work is in progress monitoring genetic changes in each generation during the course of an outbreak. Theory as well as data is required in this area: how genetic rules apply to ecological changes; how natural selection operates in the process. A preliminary model has been developed. Increased genetic knowledge of pest outbreak situations would facilitate management practices, whether for prediction, prevention, or control. All control techniques are selective processes altering the genetic structure of populations, and knowledge of these processes will sharpen management efforts.

THIRTIETH WESTERN FOREST INSECT WORK CONFERENCE
Minutes of the Final Business Meeting
March 6 - 8, 1979
Boise, Idaho

Chairman Bill Ives called the meeting to order at 8:35 a.m., March 8.

Minutes of the initial business meeting were read and approved.

Bill Ives expressed appreciation on behalf of the Conference members to the Program Chairman, Max Ollicu, and Local Arrangements Chairman, Jerry Knopf, for the outstanding conference programs.

Gene Lessard, Program Chairman for the 31st Conference, reported that this conference will be held in El Paso, Texas, in March, 1980. There were no new invitations for the 1981 meeting and Bill Ives renewed his original invitation to hold it in the Banff area, Alberta, Canada. A motion was made and passed to accept the offer.

Chairman Ives asked for committee reports:

Nominating Committee - Chairman Bill Ciesla nominated Molly Stock as new Councilor. There being no new nominations from the floor, the nominee was elected by acclamation.

Common Names Committee - Dave McComb reported for Chairman T. Torgerson, who was not in attendance. Iral Ragenovich replaced Bob Acciavatti on the Committee since Bob left for eastern USA.

Second order of business was the committee approval of the common name BLACK FIRE BEETLE proposed by Dr. Evans for Melanophila acuminata De Geer. Unless adverse comments are received from WFIWC members within 60 days, this common name will be submitted for the approval of the Common Name Committee of the Ent. Soc. of Amer.

Third order of business was the consideration of the 211 common names not on the Ent. Soc. approval list used by Furniss and Carolin in their publication "Western Forest Insects." Committee Chairman Torgersen had contacted the Ent. Soc. Committee Chairman about our plans to submit this list for approval. He suggested we break the list down into blocks or segments by order of importance and submit them in this order. Committee members are open for suggestions as to how this should be accomplished.

Ethical Practices Committee - Chairman Ron Stark discussed the related, outstanding contributions of many members. He pointed out that his task has been an onerous one and had a difficult time in making his selection of the one to be honoured with the accoutrements of the office for the coming year. He reported some startling results from his investigations: apparently some members said that this Committee should be abolished because they were afraid to attend the meetings. A likely story!

Maxine Moyer did an enviable job to uphold the high standard and long tradition of this office and for her noble efforts she was designated as the new Chairperson.

Don Dahlsten reported that W. Bushing passed away last year. Chairman Ives called for a moment of silence in his memory.

John McLean invited members to attend the joint Ent. Soc. of B.C. and Ent. Soc. of Canada meeting that will be held in Vancouver, B.C. in October, 1979.

John Schmid asked if members wanted to maintain a list on their computer or if they wanted to move it to another computer. Max Ollieau talked in favor of maintaining the current set-up. Les Safranyik said that he will look into the possibility of updating the membership list.

There being no further business, the meeting was adjourned at 9:10 a.m.

LS/am

TREASURER'S REPORT

Thirtieth Western Forest Insect Work Conference

Boise, Idaho

Balance on hand, March 6, 1979	$ 691.01	
Received from registration at Boise, Idaho	2,995.15	(+)
	$ 3,686.16	
Expenses of Boise Meeting		
Cock o' The Walk, Boise, Idaho	1,512.14	(-)
Max Ollieu (stamps, stationery)	193.66	(-)
The Coble Co.	104.59	(-)
Boise School Bus Co.	30.00	(-)
	$ 1,840.39	(-)
Balance on hand, August 8, 1979	$ 1,845.77	(U.S. funds)
Balance on hand, August 14, 1979 (Transferred from the Commercial Bank, Salem, Oregon)	$ 2,151.24	(Can. Funds)

WESTERN FOREST INSECT WORK CONFERENCE

MEMBERSHIP ROSTER

NOTE: - Members registered at the thirtieth (Boise, Idaho) conference are indicated by an *.

- The numerical code to the right of a name indicates that member's most recent conference attendance within the last 3 years.

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